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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
Bulletin 71

A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN

PART I. ASTRORHIZIDÆ AND LITUOLIDÆ

BY

JOSEPH AUGUSTINE CUSHMAN
Of the Boston Society of Natural History

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BULLETIN OF THE UNITED STATES NATIONAL MUSEUM.
Issued June 30, 1910.

ADVERTISEMENT.

The scientific publications of the United States National Museum consist of two series—the *Proceedings* and the *Bulletins*.

The *Proceedings*, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original, and usually brief, papers based on the collections of the National Museum, presenting newly acquired facts in zoology, geology, and anthropology, including descriptions of new forms of animals, and revisions of limited groups. One or two volumes are issued annually and distributed to libraries and scientific organizations. A limited number of copies of each paper, in pamphlet form, is distributed to specialists and others interested in the different subjects, as soon as printed. The date of publication is printed on each paper, and these dates are also recorded in the tables of contents of the volumes.

The *Bulletins*, the first of which was issued in 1875, consist of a series of separate publications comprising chiefly monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, and catalogues of type-specimens, special collections, etc. The majority of the volumes are octavos, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable.

Since 1902 a series of octavo volumes containing papers relating to the botanical collections of the Museum, and known as the *Contributions from the National Herbarium*, has been published as bulletins.

The present work forms No. 71 of the *Bulletin* series.

Richard Rathbun,
Assistant Secretary, Smithsonian Institution,
In charge of the United States National Museum.

Washington, D. C., *June 18, 1910.*

INTRODUCTION.

This paper is the first part of a work the intent of which is to describe and illustrate the Foraminifera of the North Pacific Ocean. This part includes the families Astrorhizidæ and Lituolidæ, together often known as the Arenaceous Foraminifera. These are usually considered the more primitive group and are therefore treated first.

The collection of recent Foraminifera in the United States National Museum has been carefully studied in so far as it represents the area in question. From the work of the various vessels of the Navy Department, the Coast and Geodetic Survey, and the Bureau of Fisheries a mass of material has accumulated which has been of great value in this work. A more detailed account of these collections will be given later.

There have been few works dealing with the Foraminifera of this area, and such records as exist have been included here. Except where acknowledgment is given, the figures have been drawn by the writer from material in the collection of the U. S. National Museum or have been reproduced from photographs taken at the National Museum of specimens in the same collection. Where recorded species are not well represented in the collection, figures from other works have been used and due acknowledgment given.

A considerable number of changes in the nomenclature and systematic arrangement have been made in an attempt to separate more clearly species and groups which, after a study of this material, seem to be distinctive.

I wish to express my great appreciation of the kindness with which the U. S. National Museum and its staff have so freely met my various needs in the preparation of this work.

JOSEPH AUGUSTINE CUSHMAN.

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

ASTRORHIZIDÆ AND LITUOLIDÆ.

By Joseph Augustine Cushman,
Of the Boston Society of Natural History.

GENERAL ACCOUNT.

The Foraminifera are for the most part minute animals varying in size from a fraction of a millimeter to several millimeters in length, but may develop a test several inches across; these, however, are rare exceptions. A few species live in fresh or brackish water, but the great majority live in the ocean. They occur at all depths, but are most frequent at moderate depths in the ocean basins, where they form characteristic deposits—the so-called "globigerina ooze." In the vicinity of tropical coral islands many species occur in great abundance.

The animal itself is a single-celled form with one or many nuclei, as will be later explained. The test, in many cases at least, is really an internal structure, as the thin film of protoplasm which covers it in the perforate forms, and probably in others, is capable of secreting the material of the test, to repair breaks, etc.

Comparatively little is known concerning the animal of the Foraminifera except in certain littoral species. The great mass of the work on the group has been confined to a study of the empty tests. In the present work the material has been dried in almost all cases. As a result little has been noted in regard to the animal itself.

As single-celled animals the Foraminifera are especially interesting, and their structures do not need explanation on the basis of organs or tissues. There is much beauty in the curves of the test and in its ornamentation, the patterns of the latter often being very intricate.

For some time after their discovery the Foraminifera were thought to be a group of the cephalopods, and many of the coiled species have the appearance of minute nautiloid cephalopods. Many of the generic names were applied before the true relationships were known.

Many of the coiled forms were early described as species of *Nautilus*, and it was not until 1835 when Dujardin recognized the relationship of the group to the rhizopods that their systematic position was finally settled.

The classification of the group has been very differently treated by later writers. Led by W. B. Carpenter, there grew up what may be termed the English school of workers on this group. Four names stand out prominently, those of W. B. Carpenter, W. K. Parker, T. Rupert Jones, and H. B. Brady. The first three especially worked on the basis of no sharp lines of demarcation between species or genera or even between larger groups. The group was supposed to be very variable, in fact so much so that genera were recognized as tentative only and not really distinct. Brady, while holding many of the same views, nevertheless described many new genera and species, drew the lines more closely for the genera, and worked out a fairly good classification of the whole group. He was, however, led by the same plea of variation to unite recent forms with often dissimilar fossil species, on the basis of similar characters in one part or another, even while the whole test was often very different. With the large series obtained in the present work it is possible to show, not only that variation is not so great as was thought by the English school, but what was by them called variation is not variation at all but definite stages in the development of the test, which often at different stages has very different characters. In the light of the present knowledge of the life history and the microspheric and megalospheric forms these supposed variations take on a decidedly different aspect and become of use in the separation of genera rather than in uniting them. While these points are not so clearly brought out in the arenaceous forms described in the first part of the present work, they are well seen in certain of the other families.

Schlumberger, in distinction from the English school, had very different ideas as to the variation and the classification of various forms. He argued that with other groups the identity of fossil and living forms becomes small in the Eocene, and in the Cretaceous is hardly known, yet the workers of the English school had no difficulties in uniting recent species with even Jurassic or still older forms. Schlumberger argued that when such similarity existed it was simply a lack of characters, and that the two forms were potentially distinct.

Distribution has been thought to be of little account in the group, either by regions or by depth. Certain species, for instance, are recorded by Brady as from 18 to 3,950 fathoms, and with a world-wide distribution. With material from scattered stations and a worker attempting to explain all differences on the basis of variation such views may be held, but with larger series from many stations, such as have been available in the present work, the material has seemed to prove the contrary in regard to many species. With the lines of demarcation of species more closely drawn, it will be apparent that certain of them have well-defined areas of distribution and are found only between certain bathymetric altitudes. Not only is this true in regard to species, but various species form definite faunas, as will be later discussed. With plenty of specimens for comparison from different areas it is fairly easy to show the specific differences and the actual amount of the variation.

Throughout the group of the Foraminifera there is a nearly complete series, from a simple gelatinous covering of the cell in some of the fresh-water forms to the complex calcareous test of the higher groups. The fresh-water forms, while not considered in the systematic part of the present work, are nevertheless of especial interest on account of their primitive characters. In *Myxotheca* the simplest sort of covering is found, a gelatinous test which is flexible, so that it takes the shape of the changing form of the cell. There is here also no definite aperture, the pseudopodia being pushed through at any point. In others of the fresh-water forms the test may be of flexible chitinous material, but has a definite shape when the animal is at rest and usually one or more definite and permanent orifices.

In the marine species, which form the basis of the present work, there is usually a definite, specific form to the test and the aperture is permanent. The materials used in making the test may be grouped in two classes, (1) those derived from foreign sources, and (2) those secreted by the animal itself. The foreign materials are derived from the bottom on which the animal lives, and therefore even in the same species found under different conditions there is some variation in the character of the materials used. In general, however, there seems to be a certain amount of selective power on the part of certain forms, and such characters have been used as of generic rank in systematic work. The foreign material most frequently used is the mud or sand of the ocean bottom, but certain forms use sponge spicules, either making them into a soft felted mass (*Pilulina*) or arranging them in a definite manner and firmly cemented (*Technitella*). Other foraminiferal tests may be used, as may various small bodies which come within the range of the animals. The cement in the agglutinated tests may be chitinous, of iron oxide, or calcareous.

Of these calcareous tests two sorts have been recognized, one with a definite aperture or series of apertures and with minute pores (the perforate group), the other with a definite aperture or series of apertures but without minute pores (the porcellanous group). By many writers the latter group, represented by the Miliolidæ, has been held to be primitive and a group which had not developed perforations. On the other hand, certain evidence, such as the perforate condition of the early chamber of *Peneroplis* and other genera, would indicate that they are derived from the perforate group and that the lack of pores instead of being a primitive condition may in reality be a specialized one derived from a condition in which pores were developed throughout the life of the individual.

In general the test of the Foraminifera may be single chambered or many chambered. Contrary to the impression given by certain works on the group, the process of adding chambers in the Foraminifera, while superficially like budding or gemmation, is not necessarily or usually accompanied by nuclear divisions. That is, instead of the new chambers being potential individuals they are simply integral parts of one cell, and in the uninucleate form the single nucleus is found in about numerically the middle chamber. In the process of adding a new chamber a portion of the protoplasm is protruded from the aperture and a new chamber wall then formed about it. In some cases a complete wall is formed with each newly added chamber, but in others the adjacent parts of previous chambers form the inner walls of the new chamber and new walls are formed only on the free parts of the protoplasmic mass. In the open tubular test, such as *Astrorhiza* or *Hyperammina*, increase in the protoplasmic body is accompanied by addition of material at the open end of the tube and an increase in size results. In single-chambered types, such as *Lagena*, the manner of increase in size is problematical, if there be any at all. In such forms the entire test may be made in its completed form at once after division, as is the case with certain of the fresh-water Rhizopods.

STRUCTURE.

COMPLEX TESTS.

In the tests having more than a single chamber the apertures of the first-formed chambers become internal, as a rule, and a complexity of relations to the outside medium is thus brought about. One of the simplest arrangements of the chambers is a linear series. Such an arrangement is seen in *Reophax* and *Hormosina*. Another very common plan of arrangement is a planospiral, as in *Ammodiscus*. This may be varied by having the revolving line in a spire and then the whole test becomes trochoid, as in *Trochammina*. Another common arrangement is a biserial one, the chambers being on opposite sides of the axis, as in *Textularia*. These four plans or some modification of them are the characteristic arrangements for the chambers in most of the secreted tests. Oftentimes more than one plan of arrangement enters into the formation of the test. Dimorphism was used for this, but that term has been used elsewhere with a very different meaning. As here viewed, this life history with several distinct methods of growth has a deeper significance than has usually been attached to it. It seems to have a definite phylogenetic bearing in each particular group, as will be shown in certain of the families to be taken up later, when the details will be discussed at length. The term "dimorphism" would hardly cover the case in some genera, where eight or more distinct stages may be made out, each with its characteristic form of chamber, yet all appearing successively in a single test.

The number of chambers in the complex tests varies from a few to a great many. Where the size of the test becomes considerable and the chambers correspondingly large, the chamber is often divided up in various ways into chamberlets, as in *Orbitolites*. In such cases the adjacent chamberlets are usually in free communication with one another. The walls of the chamberlets give additional strength in many forms in which they are developed. Another characteristic modification in some genera is the development of labyrinthic structures in the interior of the chambers. Such structures are seen in *Cyclammina*, *Haplostiche*, *Fabularia*, etc. In general, it seems to be a mark of the culmination of certain lines in development, and many of the genera which developed such labyrinthic structures are now extinct. From the appearance of a series of such tests of one species at different stages in development, it would seem as though this labyrinthic condition was developed as a secondary growth in the chamber. One of its uses may be to give added strength to the test, but this does not always seem to be the case, for it may occur in tests which are characterized by thick walls.

APERTURES.

The aperture in a given species seems to be rather constant when the development is understood. Much has been written upon this subject; apertural characters have been used by some authors as a basis for systematic work and discarded by others as very variable. In a few specimens it may seem at first sight as though the apertural characters were very variable, but with a large series showing different stages in development another phase of the matter is presented. In certain cases there is a very decided change in the condition of the aperture, but these changes appear at definite stages in the life history, and all may be seen by cutting back a single full-grown individual. In general, it has seemed from the present study that apertural characters, when studied in large series, are a rather dependable set for systematic work, and this will be shown to be true in the Miliolidæ and Lagenidæ especially.

In many species teeth of various sorts are developed in the aperture, and these teeth are subject to various modifications. It can be demonstrated that these modifications occur in a definite sequence, and that this sequence is important from a phylogenetic point of view.

In a considerable number of genera a definite tubular neck is developed, with the aperture at its end. This neck is seen in many genera in a great many modifications, and in *Lagena* the tube may be inverted and be directed into the chamber of the test.

It is obvious that a very long slit-like aperture may be a source of weakness to the test, especially when it is at the edge of a thin chamber. Usually in such cases, as in *Orbitolites,* the animal changes its aperture from a single one in each chamber to a considerable number. This is often coincident with the development of chamberlets, but not invariably so, for multiple apertures occur in *Peneroplis* where there are no chamberlets.

ORNAMENTATION.

Many of the tests of the Foraminifera are beautifully ornamented. Raised costæ, striations, knobs, spines, and punctate areas form the main types of ornamentation. Several of these or combinations of them may occur in a single species, the form of the ornamentation often changing as the chambers of the test are developed. Certain of the simpler forms of ornamentation may occur as parallelisms in widely separated groups. As a rule, the proloculum and early chambers are smooth and unornamented, but there are certain exceptions, as in *Nodosaria,* for example, where in some species ornamentation may occur on the first chamber. In specialized genera it is not uncommon to find certain of the species with the early portion of the test ornamented, but the last-formed chambers with a loss of ornamentation and a consequent development of smooth chambers. On the other hand, there may be a thickening of the test from without and the covering of the chambers already formed with a secondary growth, often spinose. Such a condition is seen in some species of *Bulimina.*

SECONDARY CANAL SYSTEMS.

Ordinarily the different parts of the test are connected with one another by the previous apertures, but in some cases, notably in *Polystomella,* there is a secondary canal system which is very complex and runs to all the parts. This has been worked out by Carpenter and others in detail.

COLOR.

The color of the empty tests in the Foraminifera is not a prominent feature. Among the arenaceous forms the cement is often ferruginous, and when the iron is in sufficiently large proportion it imparts a reddish or yellowish-brown tinge to the whole structure. With this exception the arenaceous forms are usually dependent for their coloring upon the material from which the test is made up. This material may be of various colors, from the white of coral or siliceous sands to black, with the various colors usually associated with ordinary sand particles. In living specimens of certain of the arenaceous types, *Ammodiscus* for example, the newly formed portion of the test is often of a much lighter color than the rest of the test; on the other hand, in other forms, as in *Hormosina ovicula*, the tips of the chambers are often much darker than the rest. In the chitinous tests the usual yellowish-brown color of chitinous structures is present, and is somewhat variable in its tone.

In the secreted calcareous tests the usual color is white when empty. There are various exceptions, a reddish or pinkish color being most common, such as appears in *Globigerina rubra* and *Truncatulina rosea*, or perhaps more pronounced in *Polytrema minaceum*. In other calcareous species, as in various species of *Discorbina*, there is a brown color rather prominently developed. This is often confined to the earliest chambers, and the later ones may be white. In many species when alive there is probably more or less color which disappears when the test is empty.

LIFE HISTORY.

For many of the Foraminifera two distinct phases have been discovered. One of these—the microspheric form—has a proloculum or first chamber of much smaller size than the other—the megalospheric form. These two forms are to be looked for in all species.

The microspheric form has a number of nuclei, often a larger number than there are chambers, scattered irregularly through the protoplasm of the body. There seems to be a rather definite relation between the size of the nuclei and the size of the chamber in which they occur, the larger nuclei being in the larger chambers and the reverse. Apparently these nuclei simply divide in their reproduction during the growth of the test.

When the animal attains its adult stage there is a great increase in the number of pseudopodia, and the entire protoplasm either leaves the test and accumulates about the exterior or is drawn into the outer chambers. Finally, each nucleus gathers a mass of protoplasm about itself and secretes the proloculum of a new test. This newly formed proloculum is of the larger type and is the first chamber of the megalospheric form, instead of being of the same size as that of the microspheric parent from which it was derived. The megalospheric form differs from the microspheric form in having a single nucleus. This does not divide, but moves along as new chambers are added, keeping in about the middle chamber numerically. Nucleoli appear in increasing numbers as the growth continues, and finally the whole nucleus breaks down and a great number of minute nuclei appear. These draw about themselves portions of the protoplasmic mass and then divide by mitotic division. Finally, the mass leaves the test in the form of zoospores. These are then supposed to conjugate and to give rise to the small proloculum of the microspheric form, thus completing the life cycle, although the actual process of conjugation has not definitely been observed in this group. The empty tests left behind must form a large proportion of the dredged Foraminifera. The two forms may be distinguished by the size of the proloculum and, when sufficiently known, by other characters as well.

The microspheric form is thus the result of a conjugation or a sexual process, while the megalospheric form is the result of simple division or an asexual process. As a rule the megalospheric form is by far the more common, and in many species the microspheric form is very rare, or even as yet unknown. The microspheric form, while it starts as a smaller individual, in most cases attains a much larger size than the megalospheric, as might be suspected from the nature of the reproductive processes by which it is formed. In species where there are definite stages in development it is usually the microspheric form which repeats these most fully, these stages being reduced or entirely skipped in the megalospheric form of the species.

In some cases the megalospheric form may give rise to a group of megalospheric young instead of to zoospores. On the whole, the life cycle agrees well with the alternation of generations as seen in certain other groups of animals.

PELAGIC FORAMINIFERA.

All of the Foraminifera may be divided into two classes, those which are known to live at the surface, relatively a small number, and those which have been found only on the bottom, which form the great majority.

The pelagic species number but little more than twenty, and of these few are really common at the surface. The two genera which have more than a single species are *Globigerina* and *Pulvinulina*. The following species have been taken at the surface: *Globigerina æquilateralis, G. bulloides, G. conglobata, G. digitata, G. dubia, G. inflata, G. marginata, G. sacculifera; Pulvinulina canariensis, P. crassa, P. menardii, P. patagonica, P. truncatulinoides, P. tumida; Hastigerina pelagica; Orbulina universa; Candeina nitida; Pullenia obliqueloculata; Sphæroidina dehiscens; Cymbalopora bulloides;* and *Chilostomella ovoidea.*

Of these species a few have been observed but once as single specimens, and at best are but doubtful members of this group. Others are almost never found on the bottom, and may be considered as truly pelagic species.

As a group the pelagic species are characterized by peculiar structures. In *Hastigerina pelagica*, for example, there has been noted a peculiar vacuoled condition of the protoplasm, in which it extends out from the body to several times the diameter of the test and is filled with large vacuoles. Many of the species have large apertures, and in some cases a number of secondary ones are present, especially in the last-formed chamber of the adult. There is also a tendency for the last-formed chamber to surround the preceding ones either entirely, as in *Orbulina*, or in part, as in some of the species of *Globigerina*. Some of the species develop very long spines on the surface of the test. Most of the species also develop a spherical or nearly spherical test which, as has been shown by Rhumbler, is the form which requires the least amount of secretion to cover the animal. In the matter of the size of the perforations also there is a difference, even in species of the same genus, between those living at the surface and those on the bottom, those of the surface forms being several times as large as those of the bottom ones. In general, while the various structures mentioned are also found in the bottom species to some extent, they are strikingly characteristic of the pelagic Foraminifera.

Evidently the pelagic character has been developed independently, as there are members of three or more families represented. The structures which they have developed in common, therefore, are to be regarded as parallelisms due to similar environmental conditions.

FOOD.

In general, the food of the Foraminifera consists of vegetable matter, the diatoms and algæ of various sorts furnishing the greater part. In some of the pelagic forms, however, it has been observed that copepods are caught and eaten, and some other Protozoa are also caught.

COLLECTION AND PRESERVATION.

For one living near the ocean it is very easy to obtain material for making a preliminary study of the Foraminifera. On stones, on the piles of wharves and bridges, in fact upon almost anything that is stationary for any length of time in the salt water, the Foraminifera will be found in greater or less quantity. In the sand of tide pools many species may be found, and in the sand dredged from a few fathoms there are sure to be some tests present. If locality is not important, and one merely wishes to become acquainted with the various forms, they may be found in the sand from sponges, from the "chain lockers" of ships, etc.

For the study of a definite region involving any considerable depth of water a special dredging apparatus must be used, together with the various appliances used in deep-sea work. As such methods are too elaborate for individual work as a rule, it must be left largely to government vessels and to especially equipped scientific expeditions. For getting together material for the study of a definite fauna, such as that of the North Pacific, it is necessary to depend almost wholly upon the work of such specially equipped vessels. The samples that are brought up from the ocean bottom must be washed in some way to separate the mud from the other material. One of the easiest and most expeditious ways is to shake the material in a cloth immersed in water. This quickly washes out the mud and leaves the Foraminifera with more or less sand, fine shells, and like objects. Such material when dried is easily examined, and the Foraminifera desired may be picked out with the tip of a needle moistened slightly or with a fine brush.

For the mounting of the Foraminifera for permanent preservation nothing better seems to be available than the wooden slides mentioned by Dr. James M. Flint. These are of wood with a concave boring in the middle of one side. The slides themselves are 3 inches long and one inch wide. Some of them as used in the present study have been made thin enough to fit into an ordinary slide box, and have a small concave portion, while another lot has been used nearly twice as thick, but cut at the ends so as to slide into the grooves of a slide box. These latter are drilled with a larger and deeper concavity and are used for the arenaceous and other large species. The bottom of the concavity is blackened with drop black, and the cover is made of a slip of mica held in place by a spring made of a thin strip of brass bent to conform to the two sides of the slide with enough spring in the strip to make it act as a clamp to hold the piece of mica securely. This clamp may be easily slipped off when the specimen is to be critically examined, or with a hand lens the specimen may be studied directly through the mica. The specimens are dropped into the cavity and not fastened in any way, and are therefore available at any time for studying from any side simply by removing the cover and turning the specimen to the desired position. (See figure.)

For photographing, the specimens have been fastened to the bottom by a little glue, and if desired can be easily removed for study.

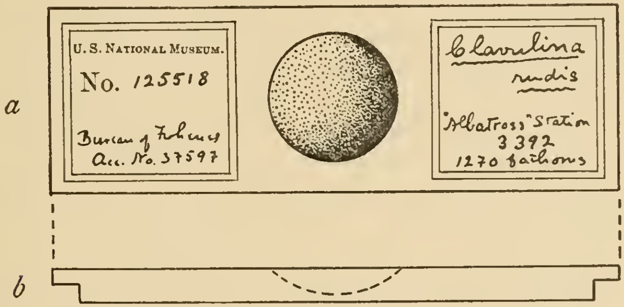
Great care should be taken in the making up of the slides to keep distinct the material from various stations, even though it may appear as all one species from widely separated localities. If previous collectors and workers had been more exact in some of these details it would now be easier to separate the various species and varieties.

In many of the families the necessity of studying sections of specimens is very great. This method, given by many writers, is the best to follow: The specimen is placed in position and fastened by a small drop of glue. When this has hardened the specimen is covered with balsam and heated until the balsam has penetrated into the chambers. After allowing the specimen to become hardened, it may be ground down on an ordinary hone, frequent observations being made to determine the plane of cutting. When the desired plane has been reached the specimen may be removed by dissolving the balsam with a little xylol and then the glue dissolved by water. By turning the specimen over and repeating the process a thin section may be obtained, which may then be mounted permanently. By this means the arrangement of chambers in the interior of a test may be studied, even when they may be entirely hidden in an ordinary external view.

HISTORICAL.

The North Pacific Ocean as a whole has received less attention, except from the United States vessels, than any of the great ocean basins. The idea has been prevalent that it was largely a vast red-clay area of great depth. This was mainly a result of the voyage of the *Challenger,* which certainly did follow a course leading over such a portion of the bottom. On the whole, the generalization is true that the ocean bed of the North Pacific is a great red-clay area. In spite of this fact, there are, as was shown by the work of the *Nero,* considerable areas of globigerina ooze containing abundant Foraminifera. As the aim in the present work is to include all records for

A


a
U. S. NATIONAL MUSEUM.
No. 125518
Bureau of Fisheries
Acc. No. 37597
Clavulina
rudis
"Albatross" Station
3392
1270 fathoms
b

B

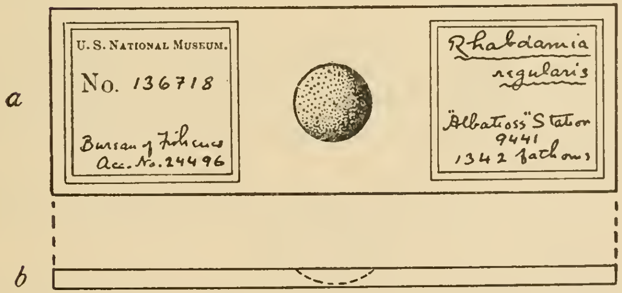

a
U. S. NATIONAL MUSEUM.
No. 136718
Bureau of Fisheries
Acc. No. 24496
Rhabdamia
regularis
"Albatross" Station
9441
1342 fathoms
b

FIG. A.—THICK SLIDE. *a,* SURFACE VIEW; *b,* SIDE VIEW, SHOWING GROOVED END FOR FITTING INTO SLIDE BOX.

FIG. B.—THIN SLIDE. *a,* SURFACE VIEW; *b,* SIDE VIEW.

this region, a short review of the work done on the Foraminifera will not be out of place.

Ehrenberg had material from many parts of the world, and some of his samples included specimens from this area. Carpenter's work really gives an idea of certain of the Philippine forms. He mentions several species as occurring here, and notes that they vary more or less from what he terms the same species from the Mediterranean. Definite data are not given, and the few species noted as occurring in the region are not given further attention in this work, as they are for the most part the larger and more common shallow-water species of the tropical coral-reef fauna.

It is in Brady's Report on the *Challenger* Foraminifera that the first real sketch of the foraminiferal fauna of the North Pacific is given, especially that of the deeper portions of the adjacent seas. A considerable number of species and varieties are recorded from this area, but the great majority of these are from three regions, really from three stations. In point of view of richness, these are, first, the coral reefs of the Hawaiian Islands, at a depth of 40 fathoms; next a station off Japan on the *Hyalonema* ground, in 345 fathoms; the third station is just west of the Philippines, in 95 fathoms. These three stations together furnished a large part of the North Pacific records of the *Challenger* Report. Many of the other stations gave but a few species; some none at all. From these facts it might be imagined that the rich fauna of this area is in the shallow water, and this has proved to be the case. As a rule, the globigerina ooze away from the oceanic islands is uninteresting, consisting almost exclusively of the pelagic types of *Globigerina, Pulvinulina, Sphæroidina,* etc. Near the islands it contains more species, but on the whole is far less interesting than the somewhat similar ooze of the North Atlantic.

In 1893 Picaglia[a] recorded twelve species from three stations in the mid-Pacific from the dredgings of the *Vettor Pisani.* Of these two were additions to the *Challenger* list.

In 1894 Schlumberger[b] recorded a number of species from a single station in the Sea of Okhotsk. Some of these were described for the first time. He noted the meagerness of the fauna of this particular portion of that ocean area, and his remarks have been confirmed by my examination of the *Albatross* material of 1906 from the same region.

In 1896 Goës reported upon the Foraminifera from the region between the Galapagos Islands and the coasts of Mexico and Central America.[c] The area covered was fairly represented in the material both as to depth and bottom conditions. A considerable number of new species was discovered, and from the list of species given much can be made out as to the characters of the fauna. Goës returned to the National Museum a set of nearly all the species he recorded, and his selected material has been carefully studied in connection with the present work.

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[a] Atti Soc. Modena, ser. 3, vol. 12, pp. 152–155.

[b] Mém. Soc. Zool. France, 1894, pp. 237–243.

[c] Bull. Mus. Comp. Zoöl., vol. 29, 1896.

In 1899 Flint's report on the *Albatross* Foraminifera [a] added to the previous knowledge by records from scattered stations on the west coast of North America and a few species from the western Pacific. Most of the stations from which the material was taken for his report were in the North Atlantic. His report on the *Nero* material [b] added a few records to the previous ones, although in that report as a rule only the genera were mentioned, the work dealing with oceanography rather than determination of the species in the deposits. Something of the general character of the fauna of various areas may be ascertained from the genera mentioned.

In 1906 Rhumbler reported [c] upon material from Laysan and the Chatham Islands. The material came from shallow water. Of the species recorded a considerable number were described as new. These records are especially interesting as they represent the littoral fauna not previously recorded, except from the Hawaiian Islands in the *Challenger* Report. Rhumbler's records show the existence of a shallow-water fauna of tropical character about these islands, and the new species indicate the individuality of these more or less isolated areas.

In 1908 Bagg [d] recorded a considerable number of species from the immediate vicinity of the Hawaiian Islands. These records add considerably to the recorded fauna of the shallower water as given in the *Challenger* Report. In this *Albatross* material the stations reported upon were mainly in globigerina ooze and for the most part lack the shallower water species so common on the coral reefs of this region. The series selected by Doctor Bagg has been examined and the results of this examination appear as the species are discussed.

Altogether the eight titles mentioned have built up a rather numerous fauna for the North Pacific, but the material that was available for all of them was rather meager when compared with the material available for the present work. As a result, not only has a very large proportion of the previously recorded species been rediscovered, but a great many species have been added, some new, and some previously described from other areas. The large series of specimens has added greatly to the ranges of distribution for species which were formerly known only from isolated stations and has shown the incorrectness of the determination of many species of this region as identical with species characteristic of the fossil beds of Europe.

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[a] Rep. U. S. Nat. Mus., 1897, (1899) pp. 249–349.

[b] Bull. 55, U. S. Nat. Mus., 1905.

[c] Zool. Jahrb. Abt. Syst., vol. 24, pp. 21–80.

[d] Proc. U. S. Nat. Mus., vol. 34, pp. 113–172.

SOURCES OF MATERIAL.

U. S. Fisheries steamer Albatross.—The greatest part of the work of making known the ocean bottom of the North Pacific has been done by the U. S. Bureau of Fisheries steamer *Albatross*. For the last twenty years the *Albatross* has been in the Pacific Ocean and has occupied several thousand dredging and hydrographic stations. In the present work these will be referred to in the usual manner, as "station D5056" or "H3228," etc. Of the *Albatross* material, that from a considerable number of stations was available from the work of the earlier years. These stations were chiefly along the Pacific coast of the United States, British Columbia, and Alaska. During the early part of 1891 dredging operations were carried on off the coast of California, Mexico, and Central America, and out to the Galapagos Islands. The material collected was worked up by Goës and is recorded in his paper already referred to. Later, in 1891 and continuing into 1892, the *Albatross* was engaged in a cable survey between California and the Hawaiian Islands. About 550 stations were occupied and a mass of material from a definite line across that part of the Pacific was gathered. As is the case in so many parts of this ocean basin, the depth for much of the distance surveyed was too great for the existence of many Foraminifera, the majority of the soundings consisting of typical red clay. In certain parts of the area, however, Foraminifera were fairly common.

In 1902 the *Albatross* made an exhaustive dredging trip in the vicinity of the Hawaiian Islands. Much of the bottom material was unfortunately destroyed, but the remainder formed the basis of the paper by Doctor Bagg on the Foraminifera of this region. Fortunately, the cable survey of 1891 and the work of the *Nero* furnished new material from a number of stations in this area, and this has been available for the present work.

In 1906 the *Albatross* made an extended voyage of exploration in the northwestern Pacific, a region practically unknown up to this time. Material from this voyage, especially from about the islands of Japan, the Sea of Japan, the Sea of Okhotsk, etc., has been available in this work and has added very greatly to the knowledge of what may be termed the "cold-water fauna" of the North Pacific. Many other species were also added from the very interesting region off the southern coast of Japan where the *Challenger* made a few hauls with such satisfactory results. Some of the *Albatross* dredgings cover the identical areas where the *Challenger* dredged, and it is interesting to find again in the *Albatross* material certain of the rare species described by Brady in the *Challenger* Report as from this region only. The more extended work of the *Albatross* adds much to our knowledge of the real distribution of these species formerly known from only a single station.

U. S. S. Nero.—Next in importance to the work of the *Albatross* has been that of the U. S. S. *Nero*, which in 1899 and 1900 made a detailed cable survey across the North Pacific from the Hawaiian Islands to Midway Island, thence to Guam, to Luzon, to Guam, to Yokohama, to Guam, to Midway Island, and then back to the Hawaiian Islands. Thus a very complete line of soundings was made, giving, in connection with the 1891–92 survey from California made by the *Albatross*, a complete line of soundings and of bottom samples across the whole North Pacific. The work of the *Nero* by actual distance of the course of the survey gives on an average a record for every few miles of the distance. Such detailed work has not been available for any such distance before. Much of the work was in very deep water in red clay areas, and the results as to the Foraminifera practically *nil*, but many areas of shallower water were covered with typical globigerina ooze conditions. The areas about the various centers of work at Honolulu, Midway, Guam, etc., gave an excellent series of Foraminifera. About 750 bottom samples from work of the *Nero*, mostly from the shallower areas, were examined and much was thereby learned in regard to actual distribution of the various species, many of the results of decided importance in delimiting faunal areas for the North Pacific.

U. S. S. Alert.—A considerable number of bottom samples was available from the work of the U. S. S. *Alert* in the western Pacific. As a rule, these were in the vicinity of the Bonin Islands and near other volcanic islands, containing in general little of interest, yet certain of the samples had many interesting species and add stations which otherwise would not have been accessible.

Miscellaneous.—Scattered material from various sources has also been available, from the China Sea, Hongkong, and various shore stations in the Philippines. All have added interesting data, although the material from such sources was not usually rich in Foraminifera.

Strangely enough, the region from which the least material was available is that of the west coast of the United States. This is partly due to the fact that the *Albatross* when in these waters is often engaged in work other than that of dredging. Enough material is available, however, to show that the region is a peculiar one in many respects.

DISTRIBUTION AND ITS FACTORS.

In relation to the Foraminifera there are three conditions which are of importance in addition to the character of the bottom—depth, temperature, and ocean currents.

In regard to the first of these conditions it may in general be said that there are almost no calcareous Foraminifera to be found in depths greater than 2,500 fathoms. There are certain exceptions to this, but the number of such exceptions is very small. In greater depths than this there are to be found certain species of the arenaceous Foraminifera, which have been found at the greatest depths that dredgings have been made. The reason for the practical disappearance of the calcareous forms below the 2,500-fathom line has not yet been definitely settled. It has been thought that the great pressure at that depth has made their dissolution much easier than at shallower depths, but this has not been conclusively demonstrated.

Besides the disappearance of certain groups of forms through dissolution, there are found to be rather definite limits to the range in depth of any particular species when a considerable series may be had for study. Many species are found only in very shallow water, such as *Alveolina*, *Amphistegina*, etc. They may be found occasionally at considerable depths in the vicinity of oceanic islands, such as Guam, where the currents carry them into deeper water, but even in such cases the tests show the effects of wave action and are as a rule tests which were apparently empty before they were carried out to this depth. In the neighborhood of such islands very strange mixtures of deep-water with shallow-water species may be found, and mingled with the other two are often many of the typical species of the globigerina ooze.

Bottom temperature has in some cases an apparent influence upon the distribution of certain species. For example, certain species of the arenaceous group which are ordinarily found in deep and cold water are found in comparatively shallow water in such regions as that of the Okhotsk Sea, where the bottom temperatures are very low. Apparently in such cases their presence at such depths is to be explained upon the basis of temperature. In a similar manner there are a certain number of species which seem to thrive only in the warm water of the tropics and are for the most part found associated with the other species of animals characteristic of coral reefs.

Ocean currents play an important part in the distribution of species in two ways—(1) by determining in part the distribution of ocean temperatures, and therefore in this way limiting or extending the range of certain species; and also (2) through their position and direction determining the distribution of the pelagic tests on the ocean floor. This will be shown in dealing with distribution of the various species of *Globigerina*.

With these various factors it is not surprising that definite faunas should exist in different parts of so large and varied a region as that of the North Pacific. In this study a number of rather definite faunas have been met with which may be clearly separated. In general the great ocean depths are very uniform, and it is in this portion of the ocean basins that universal distribution is to be looked for. Many species found at depths of 1,000 fathoms, for example, are probably to be found in similar depths in any of the great ocean basins. This is even more true of those species which are encountered at the 2,000-fathom line. At depths of less than 500 fathoms species occur which in many cases seem to have a rather limited range. Many such species have been found—species, for example, which were recorded by Brady from material from a single *Challenger* station, and have been found again in the present study on the *Albatross* material from exactly the same regions and at approximately the same depths. Such species may be considered as marking definite faunal limits where enough such species occur in any one region. On this basis the North Pacific Ocean may be divided up into several faunal regions, which, while they may have a considerable number of species in common, nevertheless have a distinctive character as a whole.

Among the most characteristic of these faunas may be mentioned the coral-reef fauna, as it may be conveniently called. This fauna, characterized by such genera as *Orbitolites, Alveolina, Peneroplis, Amphistegina, Polytrema*, etc., is found about the coral reefs of the Philippines, the Hawaiian Islands, Guam, and other of the tropical oceanic islands of this area. It is best developed about the first two groups of islands at comparatively shallow depths. In the north this fauna extends, with certain modifications, up to the southern portion of Japan, but so far as made out it is not developed at all on the eastern coast of the North Pacific. The same fauna is found in the Malay Archipelago, in various parts of the East Indies, off the northern coast of Australia, to some extent in various parts of the Mediterranean, and also a modification of it in the West Indies.

Off the coast of Central America and Mexico there is developed a peculiar fauna which is seen in a modified form in the deeper waters off the eastern coast of the Philippines. Certain of the species, or at least the genera, are also characteristic of certain parts of the extreme North Atlantic, where they have been described by Brady from the *Porcupine* and other dredgings. Some of the genera which are characteristic of this region are *Crithionina, Bathysiphon*, large species of *Reophax, Verrucina*, etc.

Off the coasts of Japan and of the Philippine Islands in green mud at depths of a few hundred fathoms there is another rather definite fauna, which is mainly characterized by many species of the Lagenidæ, such as *Sagrina bifrons* H. B. Brady, and many of the species recorded by Brady from the *Hyalonema* ground south of Japan in about 300 fathoms. This fauna appears to run northward a considerable distance along or off the Japanese coast and to extend eastward to the

Ladrone Islands and southward through the Philippines to the region north of Australia.

Besides these three, which are rather definite in their limits, there are many more minor faunas which may be made out, but which are not of sufficient importance to be mentioned here. One example, for illustration, is the cold area extending around the northern portion of the North Pacific and Bering Sea. This is marked by such species as *Polystomella sibirica* Goës, etc.

On the whole, while the North Pacific is not as interesting perhaps as is the North Atlantic, there are portions of it which are very rich in species which are represented by an abundance of specimens.

The systematic portion of the work has been written on the basis of the distribution in the North Pacific entirely, and the stations are given with this in mind. Occasionally mention of other regions is made, but only when this has some special bearing on this region.

SYSTEMATIC PART.

Order FORAMINIFERA.

Pseudopodia of fine threads, freely anastomosing to form a network; test typically with many minute foramina, in one family with a single aperture; wall of the test composed of chitinous or calcareous material when secreted, or of agglutinated sand, sponge spicules, shells, etc., usually secreting either no silica or a very little under certain conditions.

[Family 1. GROMIDÆ.

Test usually chitinous, sometimes with a covering of foreign material; apertures one or more; as a rule inhabiting fresh and brackish waters.

As all the material available for the present work consists of strictly marine material, usually dredged from altitudes of several fathoms to the greatest depths, members of this family are not to be expected. They undoubtedly occur in the fresh or brackish waters of the coasts and larger islands. They will not be further considered here.]

Family 2. ASTRORHIZIDÆ.

Test composed of agglutinated material for the most part, occasionally with a chitinous inner layer, consisting of a chamber with several openings or a tubular test open at both ends, or in certain forms, of a closed chamber with a single aperture, but throughout the family the test is not divided into a series of chambers.

The tests here included in this family are all of agglutinated material, but in some genera, such as *Rhizammina*, there is a chitinous base to which the foreign material is attached. There seems to be a regular succession of forms from *Astrorhiza*, in which there is a central chamber with many irregular openings to the tubular form open at both ends and of indefinite length, thence to the chamber closed usually except at a single point as *Proteonina* or with several apertures as in *Thurammina*. This single-chambered form then leads to the forms with a globular proloculum and an elongated chamber, but undivided. Occasionally tests are found as in *Rhabdammina discreta*, where there are external constrictions, but without complete divisions within.

Subfamily 1. ASTRORHIZINÆ.

Test consisting usually of a tube open at both ends or in some species of *Astrorhiza* with several tubes entering a central chamber; in some species with the tube branching (*Rhabdammina irregularis*, *Rhizammina algæformis*, etc.).

Included in this subfamily are five genera, *Astrorhiza*, *Rhabdammina*, *Marsipella*, *Bathysiphon*, and *Rhizammina*. With the exception of the first we know very little concerning the animal, excepting for the material of which the test is made; each consists of a simple or branching tube open at the ends, except in some species of *Astrorhiza*, where there are several tubes and a single central chamber. The growth seems to take place by the addition of material at the open ends of the tube, thus increasing the length.

Genus ASTRORHIZA Sandahl, 1857.

Astrorhiza Sandahl (type, *Astrorhiza limicola* Sandahl), Öfv. Svensk. Vet. Akad. Förh., vol. 14, no. 7, 1857, p. 299.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 230.

Astrorhiza+*Rhabdammina* (part) Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 666.

Ammodiscus Carpenter and Jeffreys, Proc. Roy. Soc. London, 1870, p. 159 (not *Ammodiscus* Reuss, 1871).

Arenistella Fischer and deFolin, Les fonds de la mer, vol. 2, 1872, p. 26.

Astrodiscus F. E. Schulze, II Jahr. Comm. wiss. Unt. deutsch. Meer in Kiel, vol. 1, 1875, p. 113.

Hæckelina Bessels, Jen. Zeitschr., vol. 9, 1875, p. 265.

Description.—Test free, flattened or tubular, composed of sand or mud loosely cemented; chamber within connecting with the exterior by the open ends of the tubes or by several definite apertures in the flattened forms.

Five species occur in the North Pacific, so far as is known. They are typically cold-water species here, as also in the North Atlantic. None of the species seem to be common so far as the material that has been examined shows.

ASTRORHIZA ANGULOSA H. B. Brady.

Astrorhiza angulosa H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 48; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 234, pl. 20, figs. 10–13.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 265, pl. 3, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 218, fig. 38 (in text).

Description.—Test depressed, subtriangular (rarely quadrangular), biconvex, rounded at the edges, interior consisting of a small central chamber from which tubes radiate, one to each angle of the test, their open ends serving as apertures; wall thickest about the central chamber, composed of fine sand, exterior of the test loose and granular, within, smoothly finished, wall about the apertures often tinged a reddish-brown.

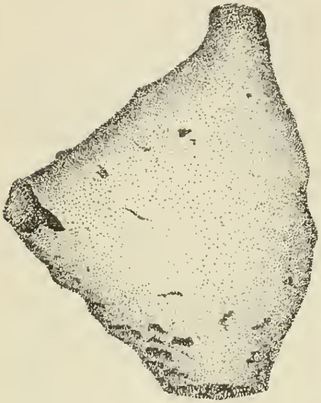


Fig. 1.—Astrorhiza angulosa. × 15.

Diameter, 2–4 mm.

Distribution.—This species was obtained by the *Albatross* at a single station, D3407, off James Island, Galapagos, in 885 fathoms from globigerina ooze.

Of the four specimens from this station in Goës' material, two have the darker-colored neck as shown in Brady's figures (pl. 20, figs. 11, 12).

ASTRORHIZA FURCATA Goës.

Astrorhiza furcata Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19, pl. 1, figs. 4, 5.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 218, fig. 39 (in text).

Description.—Test flattened below, convex above, triangular, with three tapering arms, attenuated at their ends, which serve as apertures; angles between the arms unequal, the arm opposite the smallest angle usually longer than either of the other two; wall of medium thickness, composed of mud and fine sand with occasional larger fragments; texture of wall fairly firm, more so than in most of the other species of the genus, color dark gray or almost black.

Length about 5 mm.

Distribution.—Obtained by the *Albatross* at a single station, D3419 off Acapulco, on the west coast of Mexico, in 772 fathoms in green mud. This is the type station.

The three specimens selected by Goës from the original station are figured here. They show the variation in form as well as other slight differences. One or two other specimens were also found in looking through the material from this station. The species is different in various ways from typical *Astrorhiza* but may be left here until more material can be obtained.

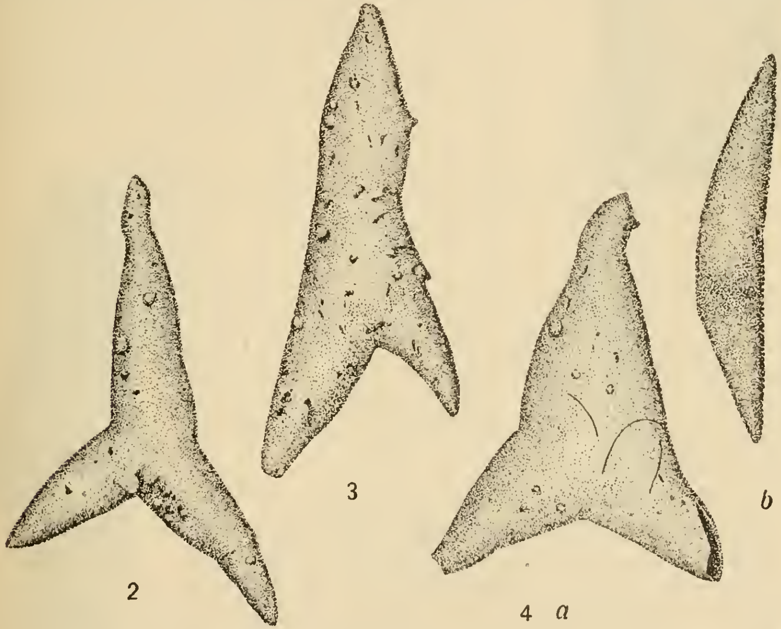
ASTRORHIZA GRANULOSA (H. B. Brady).

Marsipella granulosa H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 36, pl. 3, figs. 8, 9.—Bütschli, in Bronns, Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 194, pl. 5, fig. 9.

Astrorhiza granulosa H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 48; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 234, pl. 20, figs. 14–23.—Neumayr, Stämme Thierreichs, vol. 1, 1889, p. 173, fig. 17*d*.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 265, pl. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 219, fig. 41 (in text).

Rhabdammina granulosa Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 667.

Description.—Test fusiform, tapering toward the ends, internally with a long tubular chamber of nearly uniform diameter, open at both ends, the apertures sometimes more or less closed by particles of sand; wall composed of fine siliceous sand, loosely cemented externally, occasionally with tests of *Globigerina* or other foreign particles cemented into the test, ends often with a brownish tinge, the rest of the test grayish.



Figs. 2-4.—Astrorhiza furcata. 2, 3, 4 *a*, face view of three specimens selected by Goës from the type station; 4 *b*, side view. × 10.

Maximum length, 5–7 mm.

Distribution.—I have had material of this species from four stations in the North Pacific. Of these one is the station recorded by Goës, *Albatross* station, D3375, southwest of Panama in 1,201 fathoms from globigerina ooze. The other three stations are in the Northwest Pacific, dredged by the *Albatross* in the 1906 cruise, D4979, 943 fathoms; D5031, 86 fathoms, and D5095, 58 fathoms. The first of these stations is in the southern portion of the Japan Sea, the other two being in shallow water south of Honshu Island, Japan.

The two stations from shallow water are in the influence of cold currents and this may account for the finding of this species at depths so much shallower than the previous records.

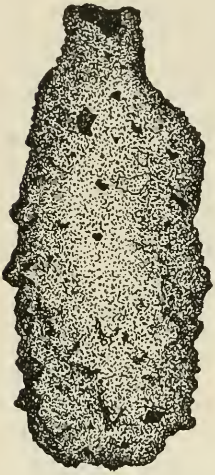


FIG. 5.—ASTRORHIZA GRANULOSA. × 10.

ASTRORHIZA CRASSATINA H. B. Brady.

Astrorhiza crassatina H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 47; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 233, pl. 20, figs. 1–9.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 13, pl. 2, figs. 11–15; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 265, pl. 2.—KIÆR, Norske Nordhavs-Exp., no. 25, 1899, p. 4.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 220, fig. 42 (in text).

Rhabdammina crassatina EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.

Description.—Test subcylindrical or irregular, elongate, ends rounded, internally with a tubular chamber, open at both ends, but of uneven diameter, the apertures often more or less closed by particles of sand; walls thick, composed of fine sand, loosely cemented at the surface; occasionally with various foreign particles.

Maximum length of typical specimens, 8–10 mm.

Distribution.—Obtained by the *Albatross* at three stations in the 1906 cruise, D4946, 39 fathoms, D4949, 110 fathoms, and D4979, 943 fathoms. These three stations are near Japan—one south of Honshu Island, the other two southeast of Kiushu Island. All three of these are within the influence of the cold currents from the north. Goës records this species from *Albatross* station D3407, off James Island, Galapagos, in 885 fathoms from globigerina ooze.

The specimens referred to this species by Goës are not typical. They are large, very rough, irregular tubes, with a very narrow and little dilated chamber, the longest specimen measuring nearly 25 mm. Just what these tubes are it is difficult to say, but their questionable position must simply be noted until living material can be studied.

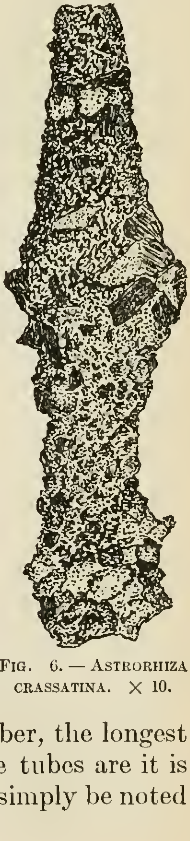


FIG. 6.—ASTRORHIZA CRASSATINA. × 10.

ASTRORHIZA TENUIS Goës.

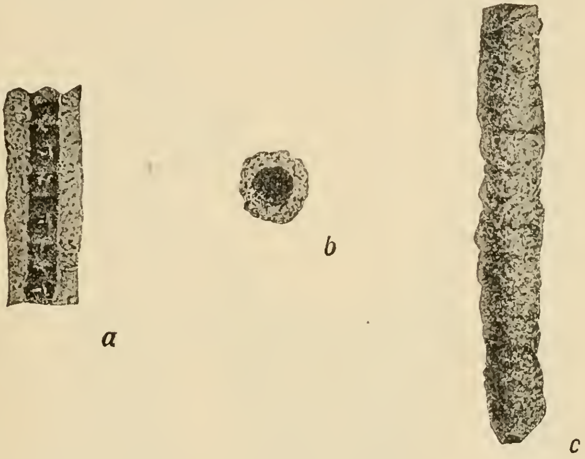
Astrorhiza tenuis Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 20, pl. 1, figs. 6–8.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 220, fig. 43 (in text).

Description.—"More or less slender cylindrical or fusiformed tubes, usually tapering to the ends, with constricted apertures. Tube channel smooth, with faint traces of spurious septa. Wall loosely cemented of coarse sand, light grayish, comparatively thick."

"Length 5–10 mm.; diameter 1–1.5 mm."

Distribution.—Described by Goës from *Albatross* station D3431, 995 fathoms, at the entrance to the Gulf of California.

In the collection at Washington there are no specimens of this species in the material returned by Doctor Goës. No specimens which can be definitely assigned to this species were found in an examination of the unsorted material from this station. The description and figures are given from Goës's original paper. It seems to me questionable whether this is a true *Astrorhiza*, but without specimens it is difficult to decide.



Figs. 7.—Astrorhiza tenuis. *a*, longitudinal section; *b*, transverse section; *c*, side view of exterior. (After Goës.) × 6.

Genus RHABDAMMINA Carpenter, 1869.

Rhabdammina M. Sars, Forh. Vid. Selsk. Christiania, 1868, p. 248 (*nomen nudum*).—W. B. Carpenter (type, *R. abyssorum* W. B. Carpenter), Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 288; Proc. Roy. Soc. London, vol. 18, 1869, p. 60.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 266.

Astrorhiza (part)+*Rhizammina* (part) Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 666.

Description.—Test free, tubular, either straight, radiating from a common center or branching, open ends of the tube serving as apertures; wall coarsely arenaceous, usually more or less rough, firmly cemented.

This genus includes five species, four of which are now known from the North Pacific. As they are, as a rule, deep-water species, little is known concerning the soft parts. It seems likely that there is a more definite beginning to such a test as that of *R. irregularis* than has been seen. All the specimens have the appearance of being broken at the lower end.

RHABDAMMINA ABYSSORUM W. B. Carpenter.

Rhabdammina abyssorum M. Sars, Forh. Vid. Selsk. Christiania, 1868, p. 248 (*nomen nudum*)—W. B. Carpenter, Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 288; Proc. Roy. Soc. London, vol. 18, 1869, p. 60.—G. O. Sars, Forh. Vid. Selsk. Christiania, 1871, pp. 250, 251.—Carpenter, The Microscope, 6th ed., 1881, pp. 562, 563, figs. 321 *c*, *d* (in text).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 266, pl. 21, figs. 1-13.—De Folin, Le Naturaliste, vol. 9, 1887, p. 127, fig. 12*a*.—A. Agassiz, Bull. Mus. Comp. Zoöl., vol. 29, 1888, pp. 162, 163, figs. 492, 493 (in text).—Newmayr, Stämme Thierreichs, vol. 1, 1889, p. 173, fig. 17*a* (in text).—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 255, pl. 4, fig. 31.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 19, pl. 4, figs. 67, 68.—Schlumberger, Mém. Soc. Zool. France, vol. 7, 1894, p. 254.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 21.—Kiær, Norske Nordhavs-Exp., no. 25, 1899, p. 4.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 271, pl. 12, fig. 2.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 264, fig. 108 (in text).

Rhabdammina abyssorum, var. *robusta* Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 143, pl. 12, figs. 430, 431.

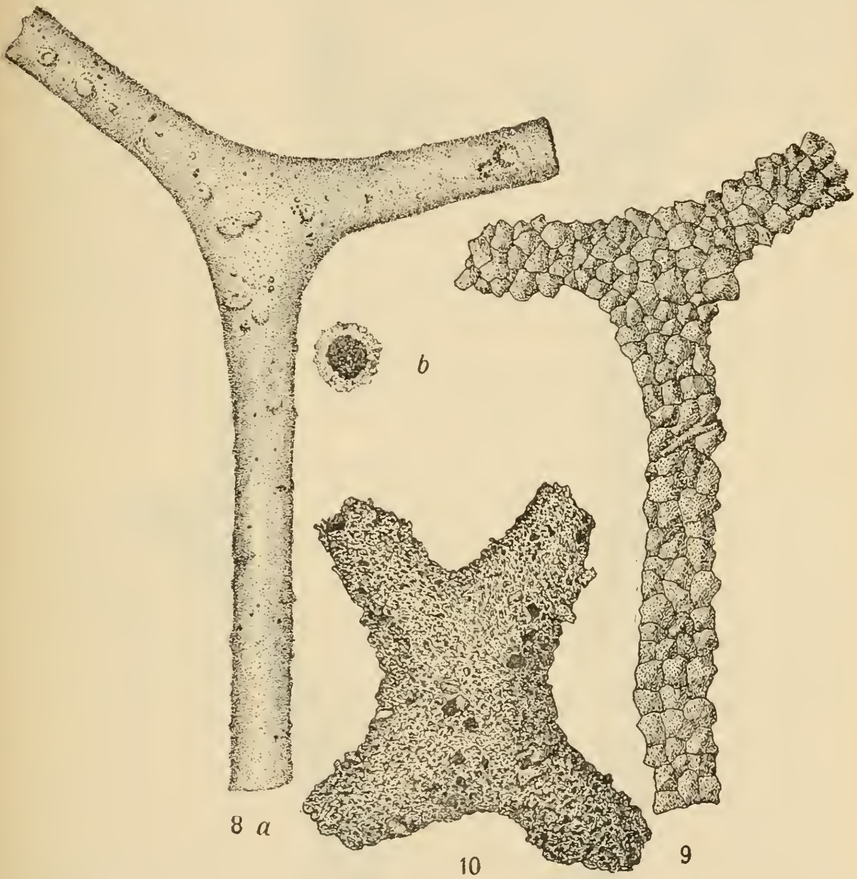
Astrorhiza abyssorum Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 666.

Description.—Test free, consisting of a central chamber with three to five radiating arms, usually three, of nearly uniform diameter and usually in the same plane, but occasionally, when there are more than three arms, the extra ones may be in a different plane from the other three, arms tubular, circular in cross section, ends open, forming the apertures of the test, wall of the test composed of very firmly cemented sand grains of variable size, exterior usually roughened but the interior smooth, wall fairly thick, cement containing ferruginous material giving the test frequently a reddish brown color, but the color varies from light gray to almost black, according to the materials of which it is composed.

Diameter, including arms, up to 17 mm.

Distribution.—The species is well distributed in the North Pacific, occurring in at least fifteen of the *Albatross* and *Nero* stations. Of these, one is the station recorded by Goës, D3375, 1,201 fathoms off the west coast of Central America; it was very abundant at D4337, 617–680 fathoms off San Diego, California; one station is in Bering Sea, D3501, in 688 fathoms. The other twelve stations were in the region south of Japan in from 71–1,759 fathoms. The species was obtained by the *Challenger* at station 237, in 1,875 fathoms, east of Japan.

There is a considerable variation in this species along certain lines. Typically there are three arms, but there are occasionally four or five, these specimens usually being rare. However, at station D4337, off San Diego, California, there was obtained a considerable series of specimens of this species and among these examples with four or even five arms were rather common. In the matter of texture of the wall there is also a considerable variation, partly due to bottom conditions it would appear from the material examined. The specimens from shallower water are more apt to be constructed of coarse sand grains, figure 9, while those from deep water where such materials are lacking are made of much finer grains with more or less mud and often contain *Globigerina* or other tests in the wall. This species has been usually found in deep water, all but four stations being in water more than 600 fathoms deep.

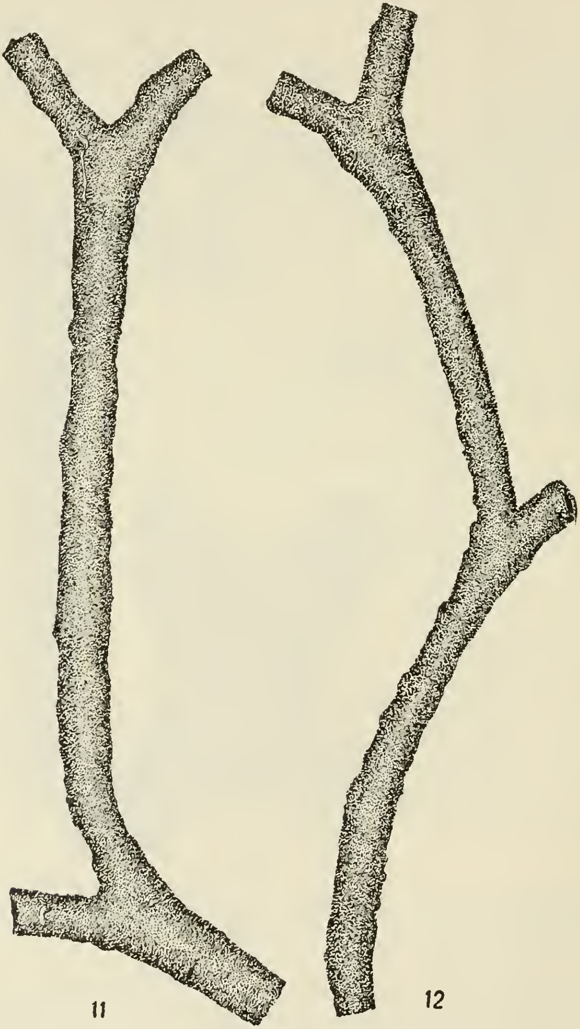


Figs. 8–10.—Rhabdammina abyssorum. 8*a*, front view; *b*, end view of one arm of the smoother form from deep water, × 10; 9, front view of a shallow water specimen from the coast of Japan, × 25; 10, central portion of a specimen with four arms, × 15.

RHABDAMMINA IRREGULARIS W. B. Carpenter.

Rhabdammina irregularis W. B. Carpenter, Proc. Roy. Soc. London, vol. 18, 1869, p. 60.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 268, pl. 21, fig. 9.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 21.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 263, fig. 106 (in text).

Description.—Test made up of a dichotomously branching tubular chamber, of nearly even diameter, wall of firmly cemented sand grains, exterior rather rough, interior smoothly finished, ends of the tubes serving as the apertures, color usually a yellowish- or reddish-brown.



Figs. 11-12.—Two specimens of rhabdammina irregularis. × 6.

Length, up to 37.5 mm.

Distribution.—In the *Albatross* material from the west coast of Mexico and Central America this species forms what may be called "Rhabdammina bottom," being the most common constituent of the bottom in several places. In the material reported upon by Goës, it occurred at *Albatross* station D3392, in 1,270 fathoms off Panama, making up the mass of the dredged material. It also occurred in 995 fathoms at station D3431, at the entrance to the Gulf of California, in great quantity. These stations give all that is known of its distribution in the North Pacific, as it has not been noted in any of the other dredged material. At these stations *Rhabdammina abyssorum* seems to be lacking.

Throughout the mass of the material few specimens were found which in any way suggested completeness of the test. Where there is a long unbranched portion at the base it is usually somewhat curved. That there may be more than the two branches is shown by the figures given here. Just what the completed specimens are can not be definitely stated with the material at hand, but a considerable size is surely indicated. There seems to be a point of weakness just above the region of forking, and the great majority of specimens are broken at that point, as shown in the figure.

RHABDAMMINA DISCRETA H. B. Brady.

Rhabdopleura, species, G. M. Dawson, Can. Nat., vol. 5, 1870, p. 177, fig. 7.

Rhabdopleura abyssorum G. M. Dawson, Amer. Journ. Sci., vol. 1, 1871, p. 206 fig. 7; Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86, fig. 7.

Rhabdammina discreta H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 48; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 268, pl. 22, figs. 11–13.—Chapman, Proc. Zool. Soc. London, 1895, p. 14.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 21, pl. 1, figs. 13, 14.—Flint, Rep. U. S. Nat. Mus., 1897, (1899), p. 271, pl. 13.—Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 263, fig. 105 (in text).—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 125.

Description.—Test cylindrical, straight or nearly so, irregularly constricted at intervals, with the effect of divisions exteriorly but no corresponding walls within, open ends of the tube serving as apertures; wall rather thin, firmly cemented of angular sand grains, roughish on the exterior, but smoothly finished on the interior except at the constrictions, where there are various angles and irregularities; color varying with the material used in the construction of the wall.

Length indefinite, up to 25 mm.

Distribution.—*Rhabdammina discreta* has been found at six widely separated stations in the North Pacific. In the eastern portion it occurs at *Albatross* station D3419, in 772 fathoms, off the coast of Mexico in the material examined by Goës. Brady records its occurrence at one *Challenger* station in the western Pacific, west of the

Ladrone Islands, in 2,475 fathoms. The *Albatross* obtained this species at two stations in the 1906 cruise—D4979, in 943 fathoms, south of Honshu Island, Japan, and D5026, in 119 fathoms in the Okhotsk Sea. Bagg records the species from station H4502 in 1,342 fathoms near the Hawaiian Islands, but his specimen is a mere fragment, poorly characterized.

The specimen figured by Goës is not typical, but there are larger typical specimens among his mounted material from the same station. Brady speaks of the occurrence of this species usually at considerable depths, but in the far north off the coast of Greenland in 20 fathoms and in the far south off Kerguelen Island at 120 fathoms. He also gives a suggestion that the distribution may be more or less affected by the temperature of the ocean bottom. In this connection it is interesting to observe that the only North Pacific station for this species at all shallow, 119 fathoms, in the Okhotsk Sea, had a bottom temperature of 30.4° F., a low temperature even for ocean bottom conditions, colder even than the deeper stations where this species occurs.

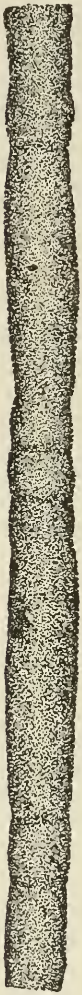


FIG. 13.—RHABDAMMINA DISCRETA. × 25.

RHABDAMMINA LINEARIS H. B. Brady.

Rhabdammina linearis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 37, pl. 3, figs. 10, 11.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 194, pl. 5, fig. 10.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 269, pl. 22, figs. 1–6.—A. AGASSIZ, Bull. Mus. Comp. Zoöl., vol. 29, 1888, p. 163, fig. 494 (in text).—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 18, pl. 4, figs. 65, 66.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 271, pl. 14, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 262, fig. 104 (in text).

Description.—Test free, elongate, straight or with the arms at an angle; central chamber of larger diameter than the two elongated tubular arms, wall of the central chamber thinner than that of the arms, composed of sand grains firmly cemented, apertures at the distal ends of the tubes; color variable, from whitish to brown according to the color of the sand of which it is composed.

Length 6–7 mm.

Distribution.—Brady records this species from the South Pacific, but in "The Summary of Results" of the *Challenger* expedition it is only given from two stations, 237 and 246, in 1,875 and 2,050 fathoms, one station east of Japan, the other in the middle of the North Pacific.

No typical example of this species was noted in the North Pacific material I have examined. Two specimens from *Albatross* station D4957, in 437 fathoms, may possibly belong here, but the central enlargement is not very pronounced.

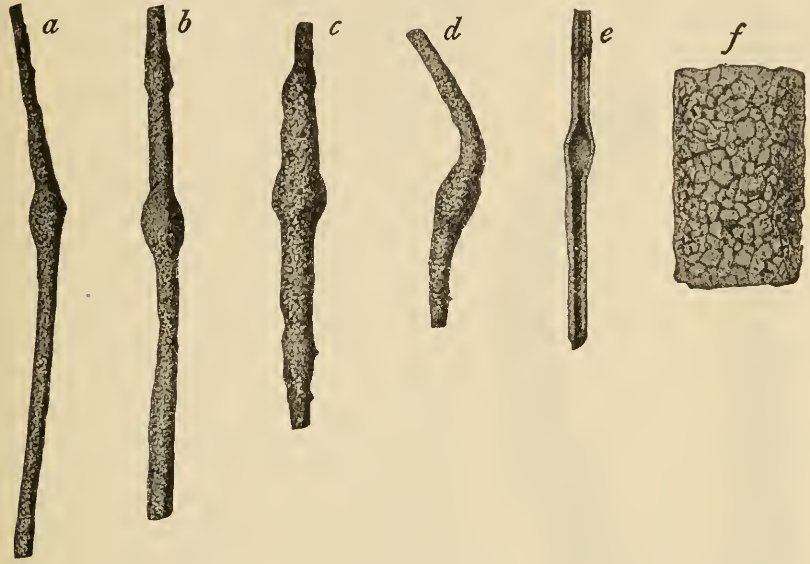


FIG. 14.—RHABDAMMINA LINEARIS. *a–e*, × 10, *e*, SHOWING INTERIOR, *f*, SURFACE. × 60. (AFTER BRADY.)

Genus MARSIPELLA Norman, 1878.

Marsipella NORMAN (type, *M. elongata* NORMAN), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 281.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 264.

Proteonina W. B. CARPENTER, Proc. Roy. Soc. London, vol. 18, 1869, p. 60 (not *Proteonina* WILLIAMSON, 1858).

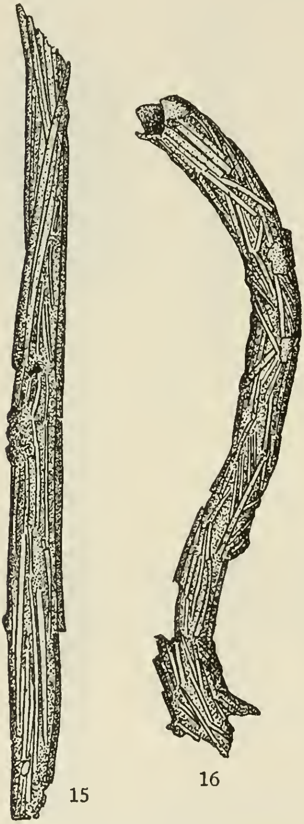
Description.—Test free, tubular, cylindrical or fusiform, sometimes recurved at the ends, apertures formed by the open ends of the tube, wall composed wholly or in part of sponge spicules, thin but firmly cemented together.

A single species has been found in the North Pacific, and that has occurred at but few stations. It has been found in the colder portions of the North Atlantic.

MARSIPELLA CYLINDRICA H. B. Brady.

Marsipella cylindrica H. B. Brady, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 714; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 265, pl. 24, figs. 20–22.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 265, fig. 109 (in text).

Description.—Test tubular, slender, of nearly uniform diameter, ends of the tube open and serving as apertures, wall composed almost entirely of acicular sponge spicules, sometimes entire but usually in fragments, laid side by side, lengthwise of the test, and strongly cemented.



Figs. 15–16.—Marsipella cylindrica. × 30. 15, straight test composed largely of long unbroken spicules. 16, rougher, doubly curved test largely made up of fragmentary portions of spicules.

Length up to 7 mm.; diameter 0.12–0.25 mm.

Distribution.—As this genus has been recorded but once previously from the North Pacific, it is interesting to find it at four stations, but in small numbers. It has occurred off the Hawaiian Islands, *Albatross* station H3009, in 603 fathoms, rare. The other three stations are about Japan. They are, *Nero* station 1225, in 805 fathoms, south of Yokohama; *Albatross* stations D4957, in 437 fathoms, off the eastern coast of Kiushu Island, and D4900, in 139 fathoms, southwest of Nagasaki. The *Challenger* obtained it at station 237, in 1,875 fathoms, east of Japan.

The tubes are often tinged with a reddish-brown color as though the cement might contain ferruginous material. The wall is comparatively thin, but may be composed of several layers of spicules.

Genus BATHYSIPHON G. O. Sars, 1871.

Bathysiphon G. O. Sars (M. Sars, in MS.) (type, *B. filiformis* G. O. Sars) Forh. Vid. Selsk. Christiania, 1871 (1872), p. 251.—Norman, Rep. Brit. Ass., 1880, pp. 389–390.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 248.—de Folin, Act. Soc. Linn. Bordeaux, vol. 40, 1886, p. 273.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 269.

Description.—Test free, cylindrical, sometimes tapering toward one end, straight or somewhat curved, often externally constricted, but without corresponding divisions of the tubular chamber internally, wall composed of sponge spicules overlaid by a varying thickness of what appears to be siliceous cement, wall thick in comparison with the diameter of the tube.

Two species of this genus have been found in the North Pacific, along the western coast of America, and again along the colder areas off the coast of Japan.

BATHYSIPHON FILIFORMIS G. O. Sars.

Bathysiphon filiformis (M. Sars MS.) G. O. Sars, Forh. Vid. Selsk. Christiania, 1871 (1872), p. 251.—Norman, Rep. Brit. Ass., 1880, p. 389.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 248, pl. 26, figs. 15–20.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 16, pl. 3, figs. 39–41.—de Folin, Act. Soc. Linn. Bordeaux, vol. 40, 1886, p. 279, pl. 6, figs. 4 *a–e*.—Chapman, Proc. Zool. Soc. London, 1895, p. 12.—Goës, Bull. Mus. Comp Zool., vol. 29, 1896, p. 23, pl. 1, figs. 11, 12.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 270, fig. 116 (in text).

Description.—Test free, cylindrical, of nearly uniform diameter, straight or somewhat curved, chamber tubular, of nearly uniform diameter, the open ends serving as the apertures; wall composed of felted sponge spicules and fine sand in varying proportions, rather soft; color light gray or white, sometimes even black, but when covered more or less by fine sand, taking on a brownish color.

Length up to 50 mm. or more; diameter up to 4 mm.

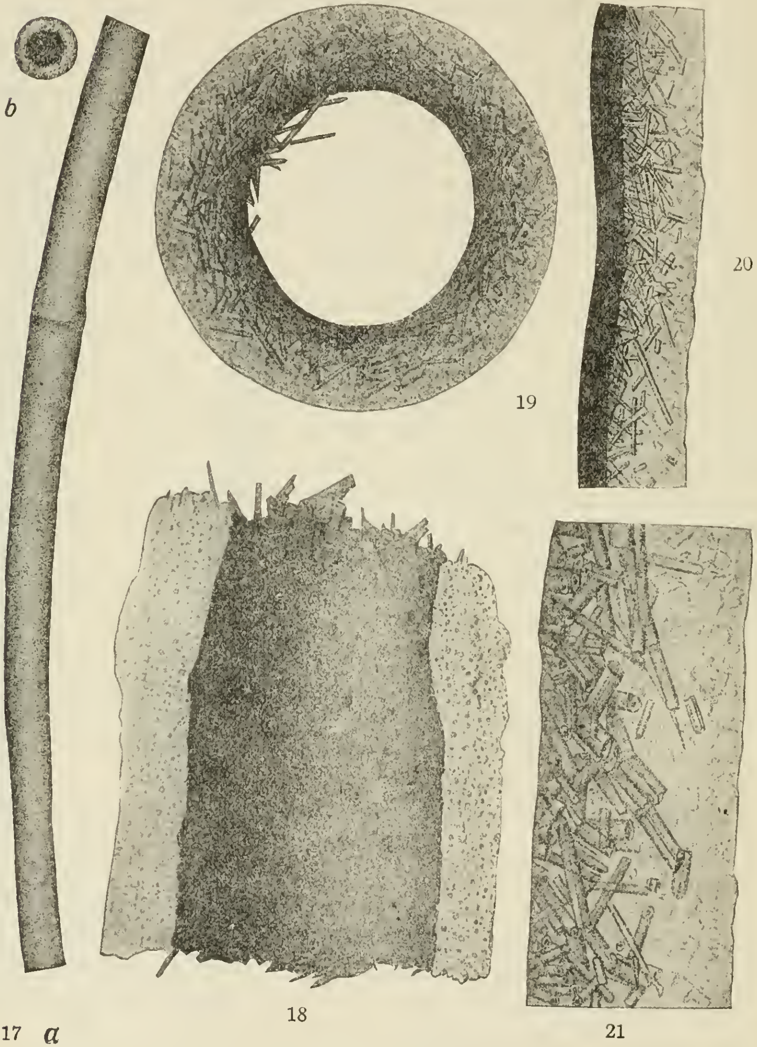
Distribution.—Specimens of this species were found by Goës in the *Albatross* material from the eastern tropical North Pacific at five stations, D3375, D3407, D3418, D3419, and D3431, in depths from 660–1,201 fathoms. I have examined Goës's material from Station D3419 and have found broken specimens in material from Station D3431. Later I obtained an abundance of fine long specimens from material dredged by the *Albatross* off San Diego, station D4337, 617–680 fathoms. These specimens were the best I have ever seen. The *Challenger* obtained specimens from station 237, in 1,875 fathoms, east of Japan.

Some of the specimens have a very considerable amount of arenaceous material built into the outer part of the wall, giving a very different appearance from that of typical specimens. These, however, are of the same size and shape and are associated in the material from the same station. In his list in 1896, page 92, Goës used the name, var. *arenosus* for this form with the sandy exterior, and his material has still another name, although neither was used in his original text. The constrictions of the wall are not prominent, as in the material figured by Brady.

Several fragmentary specimens were found at *Albatross* station D 5056, in 258 fathoms, in Suruga Gulf, Japan. These are somewhat smaller than the other material referred to and have a considerable range of variation in the character of the test.

BATHYSIPHON RUFUS de Folin.

Bathysiphon rufum de Folin, Act. Soc. Linn. Bordeaux, vol. 40, 1886, p. 283, pl. 6, figs. 8 *a–c*.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 23, pl. 1, fig. 10.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 267, pl. 7.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 270, fig. 118 (in text).



Figs. 17–21.—Bathysiphon filiformis. 17, *a*, side view, × 4; *b*, end view, × 5. 18, longitudinal section, × 60. 19, transverse section, viewed by transmitted light, × 60. 20, longitudinal section of wall with exterior coat, × 60. 21, longitudinal section of inner portion of wall, × 200. (Figs. 18–21. after Brady.)

Description.—Test free, elongate, tapering, slightly curved, surface with many irregularly placed constrictions, smooth and polished, wall comparatively thick, composed of sponge spicules and a very hard siliceous cement, color reddish or yellowish brown.

Length up to 12 mm.; diameter about 0.5 mm. in the broadest part.

Distribution.—Goës records this species from three *Albatross* stations, D3375, D3376, in 1,201 and 1,132 fathoms, respectively, south of Panama, near the equator; the other, D3419, in 772 fathoms, off Acapulco, on the Mexican coast. I have seen material from station D3376, consisting of eight specimens selected by Goës, and one of which is here figured. Specimens were also seen from station D 3407, just south of the equator, in this same region, in 885 fathoms. A single specimen was found in material from *Alert* station 1156, 2,046 fathoms, south of the Bonin Islands.

The specimens are much more constricted than those figured by de Folin, and none of them has the very small aperture or the finish shown in the larger end of the original specimens figured.

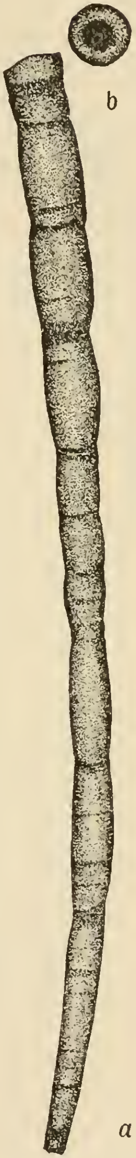


Fig. 22.—Bathysiphon rufus. × 20. *a*, side view; *b*, end view.

Genus RHIZAMMINA H. B. Brady, 1879.

Rhizammina H. B. Brady (type, *R. algæformis* H. B. Brady), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 39.—Bütschli in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 195.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 274.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 252.

Marsipella (part) Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.

Description.—Test free, consisting of a simple or dichotomously branching flexible tube, wall largely chitinous, bearing various foreign bodies attached to the exterior.

But two species of this genus are known, both occurring rarely in the North Pacific. The flexible character of the wall is a distinctive feature.

RHIZAMMINA ALGÆFORMIS H. B. Brady.

Rhizammina algæformis H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 39, pl. 4, figs. 16, 17; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 274, pl. 28, figs. 1-11.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 20.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 272, pl. 15, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 252, fig. 92 (in text).

Description.—Test free, consisting of a dichotomously branching flexible tube, forming tangled masses of indefinite size; wall thin, largely chitinous, but with various sorts of foreign matter attached to the exterior, either sand or other foraminiferal tests according to the character of the bottom, surface when free from foreign matter roughened, color of the chitinous tubes brown.

Diameter 0.126–0.315 mm.

Distribution.—But four stations are known in the North Pacific for this species. Three of these are *Challenger* stations, 237, 244, 246, in 1,875, 2,900 and 2,050 fathoms, respectively; two in the middle of the North Pacific, the shallowest one east of Japan. Goës found the species at *Albatross* station D3415, off the coast of Mexico, in 1,879 fathoms. This material of Goës which I have examined is typical, without any appreciable amount of foreign material adherent to the tubes.

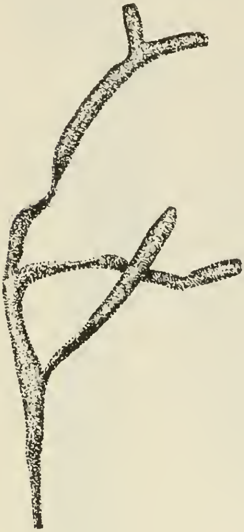


Fig. 23.—Rhizammina algæformis. × 10.

As the experiments of Brady show, the test is very largely made up of chitinous material with a small amount of silica in the wall.

RHIZAMMINA INDIVISA H. B. Brady.

Rhizammina indivisa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 277, pl. 29, figs. 5–7.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 256, pl. 4, fig. 17.—Chapman, Proc. Zool. Soc. London, 1895, p. 14.—Goës, Bull. Mus. Comp. Zoöl. vol. 29, 1896, p. 20.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 272, pl. 15, fig. 2.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 252, fig. 91 (in text).

Marsipella indivisa Eimer, and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.

Description.—Test free, cylindrical, flexible, often tapering toward the ends, which are open and serve as apertures, wall composed largely of chitinous material but with a variable amount of sand or foraminiferal tests attached to the exterior.

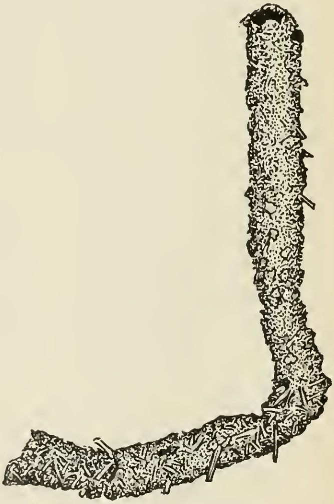


Fig. 24.—Rhizammina indivisa. × 20.

Length up to 10 mm.; diameter 0.25–0.40 mm.

Distribution.—The only previously recorded station for this species in the North Pacific is *Albatross* station D3375 in 1,201 fathoms in globigerina ooze southwest of Panama. Goës's material consists of six specimens from this station. Some of them are not this species but belong evidently to *Pelosina cylindrica* H. B. Brady. Fragmentary material referred to this species has been noted in the samples from three *Nero* stations between Midway Island and Guam, Nos. 172, 1583, and 1678, in 2,086, 777, and 1,283 fathoms, respectively, all in globigerina ooze.

Subfamily 2. SACCAMMININÆ.

Test consisting of a single chamber, or group of superficially attached chambers, the walls made up for the most part of agglutinated material; apertures sometimes numerous but usually single; tests free or attached.

Included here are a number of genera which seem to have certain common characters; that of a test of agglutinated material of a single chamber, usually with a single opening. The wall may be greatly varied in its constituents in the various genera, being composed of sand grains in *Proteonina*, of a single layer of sponge spicules in *Technitella*, of a felted mass of spicules in *Pilulina*, or of other tests, etc., in *Pelosina cylindrica*.

Genus PSAMMOSPHÆRA F. E. Schulze, 1875.

Psammosphæra F. E. Schulze (type, *P. fusca* F. E. Schulze), II Jahr. Comm. wiss. Unt. deutsch. Meer in Kiel, 1875, p. 113.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 202.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 249.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 267.—Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 598.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 241.

Saccammina (part) Rhumbler, Zeitschr. wiss. Zool. vol. 57, 1894, p. 462; Nachr. kön. Ges. Wiss. Göttingen, 1895, pp. 81, 82.

Description.—Test free or attached, usually spherical, no definite aperture, the pseudopodia making their way out between the elements of the test; wall composed of sand grains or other loose material cemented together.

Two species of this genus occur in the North Pacific, but both of them are rare and have been found at but few stations.

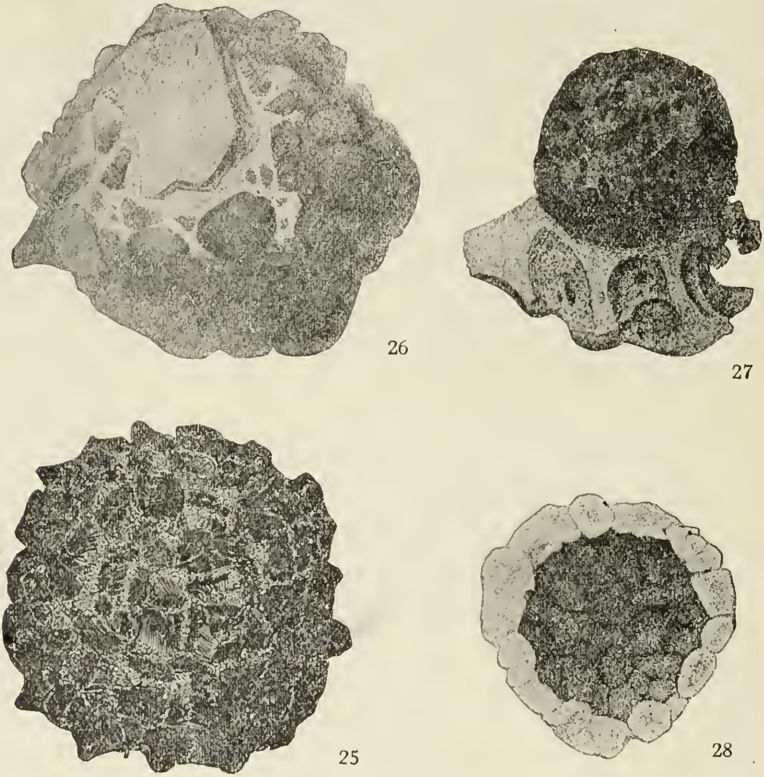
PSAMMOSPHÆRA FUSCA F. E. Schulze.

Psammosphæra fusca F. E. Schulze, II Jahr. Comm. wiss. Unt. deutsch. Meer in Kiel, 1875, p. 113, pl. 2, figs. 8 *a-f*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 249, pl. 18, figs. 1, 5–8 (not 2–4).—Goës, Kongl. Svensk. Vet. Akad. Handl, vol. 25, no. 9, 1894, p. 14, pl. 3, fig. 19.—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 268, pl. 8, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1899, p. 251.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 242, fig. 75 (in text).—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 1, pl. 1, fig. 1.

Description.—Test free or attached, generally spherical, no definite aperture: wall composed of a single layer of rather coarse sand grains, rather roughly put together, cement gray or brownish.

Diameter 1.5–4 mm.

Distribution.—Brady records this species from but two *Challenger* stations in the North Pacific, in 1,850 and 1,875 fathoms, west of the Caroline Islands, and west of Japan. Flint records it at one *Nero* station, No. 152, in 3,026 fathoms, east of Midway Island. I have specimens from two other *Nero* stations, Nos. 1153 and 1315, in 1,932 and 1,494 fathoms, near the Bonin Islands in the Western Pacific.



FIGS. 25-28.—PSAMMOSPHÆRA FUSCA. 25, SPECIMEN COMPOSED OF BLACK VOLCANIC SAND, × 25. 26, FREE SPECIMEN, × 20. 27, ATTACHED SPECIMEN, ×40. 28, SECTION OF TEST, × 40. (FIGS. 26–28. AFTER BRADY.)

PSAMMOSPHÆRA PARVA Flint.

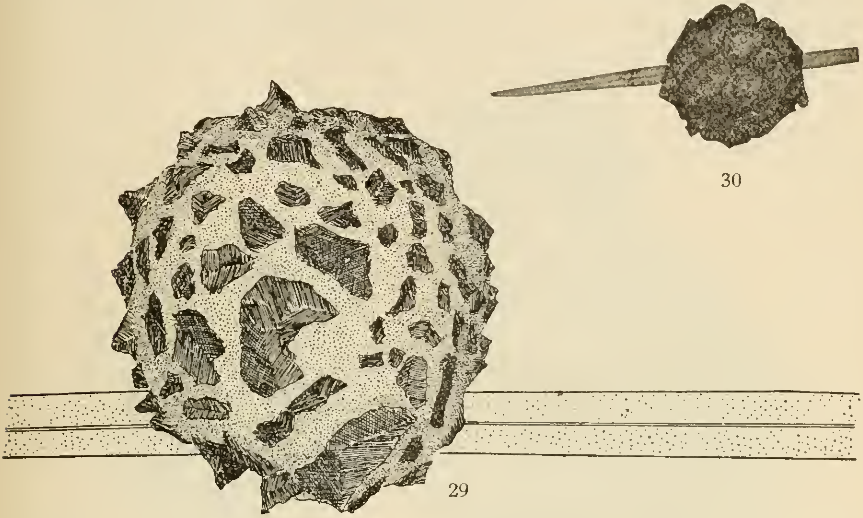
Psammosphæra parva FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 268, pl. 9, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 242, fig. 77 (in text).

Psammosphæra fusca (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 250, pl. 18, figs. 2–4 (not 1, 5–8).

Description.—Test free or attached, often attached to or inclosing a sponge spicule, spherical, if free, or frequently with a flattened area when attached, no definite aperture, wall thin, composed of fine sand, the particles firmly united by an abundance of cement which fills up the interstices to a large extent, color grayish or brown.

Diameter usually less than 1 mm.

Distribution.—Specimens which seem to be referable to this species have been noted at three stations in the North Pacific—*Albatross* station H2899 in 1,531 fathoms, east of the Hawaiian Islands, and D4979 in 943 fathoms, south of Honshu Island, Japan, also *Nero* station 1321, in 1,618 fathoms near the Bonin Islands.



FIGS. 29–30.—PSAMMOSPHÆRA PARVA. 29, SPECIMEN ATTACHED TO LARGE SPONGE SPICULE, × 50. 30, SMALLER SPECIMEN (AFTER BRADY), × 40.

There seems to be some variation in color in the specimens and the degree to which the cement fills the irregularities of the wall.

Genus SOROSPHÆRA H. B. Brady, 1879.

Sorosphæra H. B. BRADY (type, *S. confusa* H. B. BRADY), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 28; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 251.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 235.

Description.—Test consisting of a colony of more or less inflated chambers, without definite apertures, the walls joined to one another, composed of sand grains with interstitial openings.

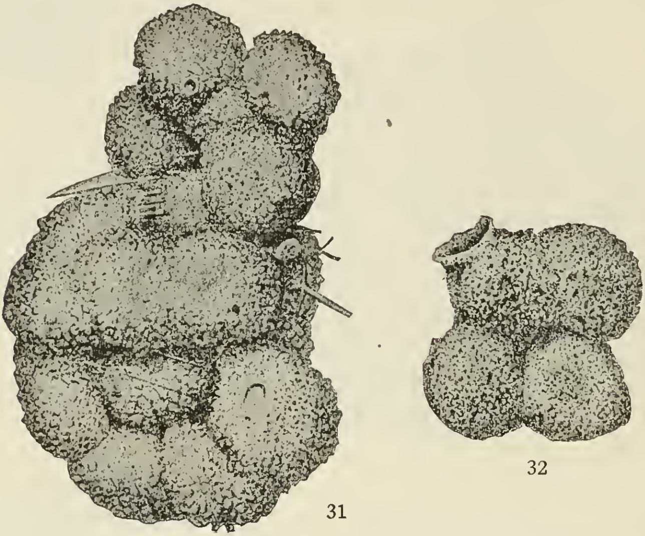
The following species has been recorded from the North Pacific by Brady:

SOROSPHÆRA CONFUSA H. B. Brady.

Sorosphæra confusa H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 28, pl. 4, figs. 18, 19; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 251, pl. 18, figs. 9, 10.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 235, fig. 63 (in text).

Description.—"Test free, consisting of a number of inflated or spherical chambers of nearly uniform size, irregularly crowded together and adhering to each other by their outer surfaces. Walls thin, finely arenaceous in texture, with minute interstitial orifices. General aperture wanting. Diameter of individual chambers about one-twenty-fifth of an inch (1 mm.), of the entire colony, variable, sometimes one-sixth of an inch (4.5 mm.)."

Distribution.—Brady records this species at one *Challenger* station, 244, in the middle of the North Pacific in 2,900 fathoms. In the volume on "Summary of Results" this species is also given as occurring at station 246, in 2,050 fathoms. This station is also in mid-ocean.



FIGS. 31-32.—SOROSPHÆRA CONFUSA. × 15 (AFTER BRADY).

The species has not been noted in any of the *Albatross* or *Nero* material I have examined from the North Pacific. The above description and figure 8 are from Brady.

Genus SACCAMMINA Carpenter, 1869.

Saccammina (M. SARS type, *S. sphærica* G. O. SARS, Forh. Vid. Selsk. Christiania, 1868 (1869), p. 248) [*nomen nudum*].—CARPENTER, Ann Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 289.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 195.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 252.—RHUMBLER, Zeitschr. wiss. Zool., vol. 57, 1894, p. 462.—EIMER and FICKERT (part), Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 242.

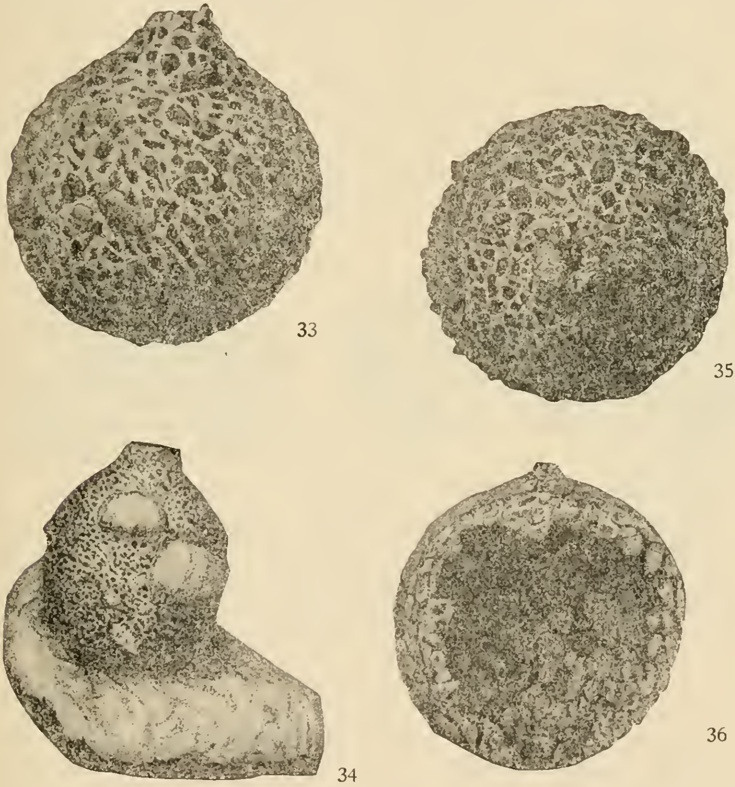
Description.—Test free, or sometimes attached, of one or several spherical chambers with distinct apertures, usually one for each chamber, wall composed of sand grains attached firmly to one another by a yellowish or brownish cement.

Two species of *Saccammina* occur in the North Pacific. The first of these, *S. sphærica*, has been found at numerous stations in the colder waters, but the other species, *S. socialis*, seems to be very rare.

SACCAMMINA SPHÆRICA G. O. Sars.

Saccammina sphærica (M. Sars, Forh. Vid. Selsk. Christiania, 1868 (1869), p. 248, *nomen nudum*), G. O. Sars, Forh. Vid. Selsk. Christiania, 1871, p. 250.—Carpenter, The Microscope, 5th ed., 1875, p. 532, fig. 272*a–c*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 253, pl. 18, figs. 11–17.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 254, pl. 4, fig. 8.—Rhumbler, Zeitschr. wiss. Zool., vol. 57, 1894, pp. 433–619, pls. 21–25.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 13, pl. 3, figs. 16–18.—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 26.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 269, pl. 9, fig. 2.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 243, figs. 78*a–d* (in text).

Description.—Test free, rarely attached, spherical or pyriform; typically of a single chamber with a single aperture at the end of a slightly projecting portion of the test; wall composed of fairly coarse sand grains, firmly cemented; color various, gray to almost black, occasionally brownish or reddish.



Figs. 33-36.—Saccammina sphærica. × 15 (after Brady). 33, free specimen. 34, attached specimen. 35, apertural view. 36, section.

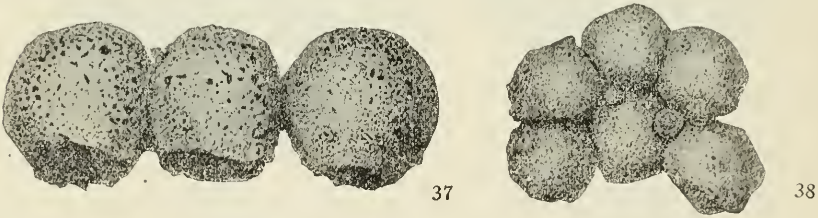
Diameter 1–3.5 mm.

Distribution.—This species appears to be fairly well distributed in the North Pacific in the colder waters. The *Challenger* dredged specimens at station 246 in 2,050 fathoms in the middle of the North Pacific. Goës records it from three *Albatross* stations off the coast of Mexico in 660–995 fathoms. His selected material which I have seen, from the entrance to the Gulf of California, is very large and more like the typical Arctic material. I have found the species in material in 2,085 fathoms, *Albatross* station H2833, midway between San Francisco and the Hawaiian Islands; also from several stations south of Japan in the colder water, in 139–1,551 fathoms.

SACCAMMINA SOCIALIS H. B. Brady.

Saccammina socialis H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 255, pl. 18, figs. 18, 19.—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 244, fig. 79 (in text).

Description.—"Test consisting of several independent arenaceous chambers, individually spherical or subspherical in shape and of nearly even size, attached to each other by their outer surfaces, but without stoloniferous intercommunication, each chamber having its own external aperture. Spheres seldom more than six or eight in number, and usually arranged with more or less regularity. Texture finely sandy, nearly smooth externally. Diameter of the individual chambers, one-thirtieth of an inch (0.8 mm.) or less."



Figs. 37-38.—Saccammina socialis. × 20 (after Brady).

Distribution.—Brady described this species from *Challenger* station 246, 2,050 fathoms, in the middle of the North Pacific. I have seen no material of this species in all the North Pacific material examined. The figures and description are from the originals of Brady.

Genus PROTEONINA Williamson, 1858.

Proteonina Williamson (type, *P. fusiformis* Williamson), Recent Foraminifera of Great Britain, 1858, p. 1 (not *Proteonina* Terquem, 1875).—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 244.

Reophax (part) H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 199.

Reophax Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82.

Difflugia Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1895, p. 251 (not *Difflugia* Leclerc, 1815).

Saccammina (part) Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.

Description.—Test free, consisting of a single chamber, flask-shaped or fusiform with a single aperture, wall composed of coarse sand grains or other foreign matter, test usually broadest near the base and gradually tapering more or less evenly to the apertural end.

Several species of *Proteonina* occur in the North Pacific, certain of the species apparently confined to specific regions as far as the material is able to indicate.

PROTEONINA FUSIFORMIS Williamson.

Proteonina fusiformis WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 1, pl. 1, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 248, fig. 84 (in text).

Reophax fusiformis H. B. BRADY, Denkschr. kais. Akad. Wiss. Wien, vol. 43, pt. 2, 1882, p. 99; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 290, pl. 30, figs. 7-11.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 253, pl. 4, fig. 11.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 125.

Lituola fusiformis J. WRIGHT, Rep. Belfast Club, 1876-77, Append., table.

Lituola nautiloidea, var. *scorpiurus* W. B. CARPENTER, in Parker and Jones, Intr., Study Foram. 1862, Append., p. 309.

Description.—Test free, fusiform, asymmetrical, chamber either single or somewhat incompletely divided, walls composed of fairly coarse sand grains, rough externally, but closely cemented, aperture terminal, single.

Length 0.63-1.0 mm. or more.

Distribution.—This species does not seem to be common in the North Pacific, but four stations being known. The *Challenger* found it near the Philippines, Station 209, 95 fathoms. Doctor Bagg records it from the Hawaiian Islands, *Albatross* station H4585, 689 fathoms. It has also been noted from two *Nero* stations in the vicinity of the Bonin Islands, in 1,415 and 1,543 fathoms.

Specimens of this species are always more or less irregular in form, but the general character of Williamson's figure is readily distinguished in the specimens.

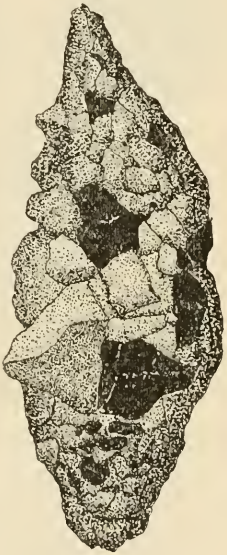


FIG. 39.—PROTEONINA FUSIFORMIS. × 75.

PROTEONINA DIFFLUGIFORMIS (H. B. Brady).

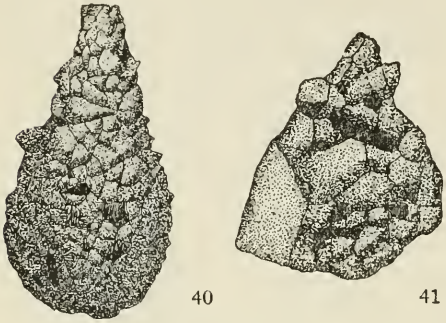
Reophax difflugiformis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 51, pl. 4, figs. 3 *a*, *b*; Denkschr. kais. Akad. Wiss. Wien, vol. 43, pt. 2, 1882, p. 99; Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289, pl. 30, figs. 2-4 (not 1, 5).—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 26, pl. 6, figs, 196-198; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 28.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 272, pl. 16, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 252.

Saccammina difflugiformis EIMER and FICKERT, Zeitschr. wiss. Zool., vol 65, 1899, p. 671.

Proteonina difflugiformis RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 245, figs. 80 *a*, *b*, (in text).

Description.—Test free, consisting of a single elongate oval or pyriform chamber, with a more or less distinct tubular neck; chamber undivided; wall fairly thick, composed of closely cemented sand grains of variable size and roughness; aperture simple, terminal; color, varying with the material of the wall.

Length 0.36–0.75 mm.



Figs. 40–41.—Proteonina difflugiformis. 40, a typical elongate specimen of fine sand grains. × 80. 41, an irregular specimen with larger sand grains, the large fragments at the left causing a distortion of the outline of the test. × 50.

Distribution.—The various records for this species are all in rather cold or deep water as far as the North Pacific is concerned. Brady records it in the deep water of the Northwest Pacific, in 2,300–3,950 fathoms. Goës found the species in material from off the west coast of Mexico and southwest of Panama, *Albatross* stations D3415 and 3376 in 1,879 and 1,132 fathoms, respectively. I have examined Goës's material from the latter station.

Specimens referable to this species have been found in the *Albatross* material from the Northwest Pacific, stations D4957, D4979, and D5095, in 437, 943, and 58 fathoms, respectively. These stations are in the cold area off the southeast coast of Japan.

PROTEONINA DIFFLUGIFORMIS (H. B. Brady), var. LAGENARIUM (Berthelin).

Haplophragmium lagenarium Berthelin, Mém. Soc. Géol. France, vol. 1, no. 5, 1880, p. 21, pl. 24, fig. 2.

Reophax difflugiformis (part) H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289, pl. 30, figs. 1, 5 (not 2–4).

Reophax difflugiformis, var. *lagenarium* Millett, Journ. Roy. Micr. Soc., 1899, p. 253, pl. 4, fig. 8.

Proteonina difflugiformis-lagenarium Rhumbler, Arch. Protistk., vol. 3, 1903, p. 247, fig. 80 *c* (in text).

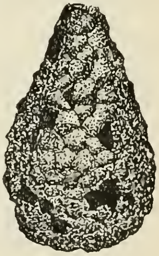


Fig. 42.—Proteonina difflugiformis, var. lagenarium. × 75.

Description.—Variety differing from the typical by lacking the distinction between body and neck; elongate, exterior rough, usually smaller than the typical and more nearly cylindrical.

Length about 0.25–0.40 mm.

Distribution.—This variety has been noted at but two stations in the North Pacific, occurring at *Nero* station 1444, in 2,175 fathoms, near Guam, Ladrone Islands, and at *Albatross* station D4967, 244 fathoms, off Japan.

PROTEONINA OVATA, new species.

Description.—Test free, ovate in side view, nearly circular in end view, wall thick, composed of neatly cemented and fairly large sand grains, apertural end abruptly contracted to form a short, tapering neck with the very small aperture at its extremity; color light yellowish or brownish gray; fairly large

Length about 1.25 mm.; diameter about 0.6 mm.

Distribution.—Specimens of this species have been seen in material from but two stations, *Albatross* H3007, in 323 fathoms, and Nero station 2071, in 271 fathoms, both near the Hawaiian Islands.

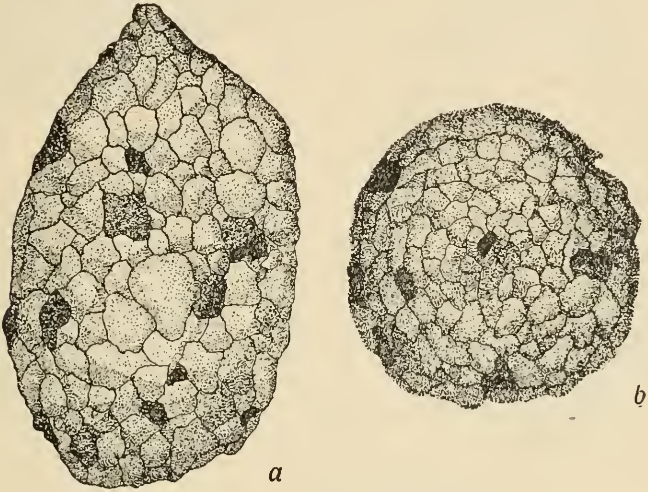


FIG. 43.—PROTEONINA OVATA. × 50. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

Type-specimen.—Cat. No. 8264, U.S.N.M., from *Nero* station 2071.

The species is a fairly large one. The form, abrupt contraction of the neck with the very small aperture, will at once distinguish this from other described species.

Genus PILULINA W. B. Carpenter.

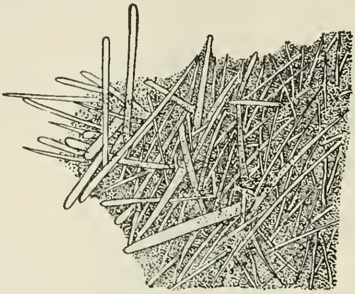
Pilulina W. B. CARPENTER, (type, *P. jeffreysii* W. B. CARPENTER.) Descr. Cat. Objects Deep-Sea Dredging [1870], p. 5.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 244.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 249.

Description.—Test free, globular or ovate, consisting of a single undivided chamber, wall composed of felted sponge spicules and a slight amount of fine sand without cement, aperture elongate, with a somewhat depressed area about it.

A single species was described by Carpenter from the North Atlantic. A new species has been found in material dredged by the fisheries steamer *Albatross* north of Japan differing in certain characters from the species described by Carpenter. The wall of these species is rather unique, as no cement seems to be used, the long spicules being felted together into a thin wall.

PILULINA OVATA, new species.

Description.—Test ovate in side view, broadly elliptical or nearly circular when viewed from the apertural end; walls very thin, smooth, composed of felted sponge spicules and fine amorphous material;



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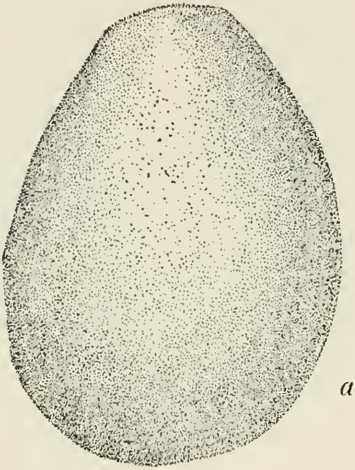

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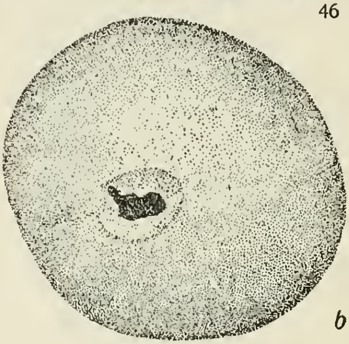

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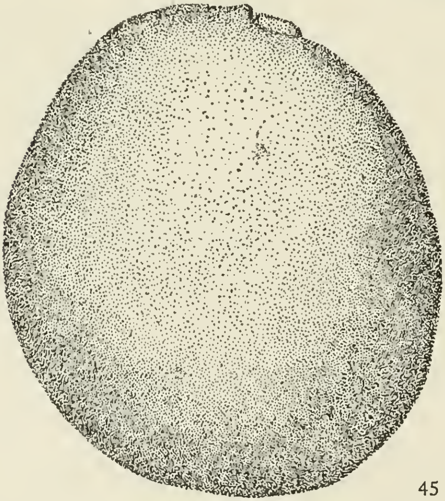

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FIGS. 44–46.—PILULINA OVATA. 44, *a*, SIDE VIEW OF ONE OF THE SMALL SPECIMENS, × 20; *b*, SAME FROM THE APERTURAL END. 45, A LARGE SPECIMEN FROM THE SIDE. × 12. 46, A PORTION OF THE WALL BY TRANSMITTED LIGHT. × 100.

aperture irregular in shape, elongate, situated in an oval depression at the smaller end of the test; color white.

Largest specimens 5 mm. in length; 3 mm. in diameter.

Distribution.—A number of specimens of this species were obtained by the fisheries steamer *Albatross* on the 1906 cruise in the Northwest Pacific. They are from station D5056, in 258 fathoms, in Suruga Gulf, Japan.

Type-specimen.—Cat. No. 8257, U.S.N.M., from the above station.

This species differs from *Pilulina jeffreysii* Carpenter in its general form, in its very thin walls, and in the character of its aperture. It may belong to a new genus as it differs in characters of rather more than specific importance. *Pilulina jeffreysii* is only known from the North Atlantic and this species is widely separated geographically as well as by distinctive characters.

Genus PELOSINA H. B. Brady, 1879.

Pelosina H. B. BRADY (type, *P. variabilis* H. B. BRADY), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 30.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 194.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 235.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 238.

Description.—Test free, variously formed, rounded, cylindrical or irregularly elongate; wall usually thick, composed of mud with a chitinous basal layer, exterior often with various foreign bodies included in the test; aperture typically single and terminal.

Three species of *Pelosina* are known from the North Pacific, but all of them seem to be rare, and for the most part they occur in deep water.

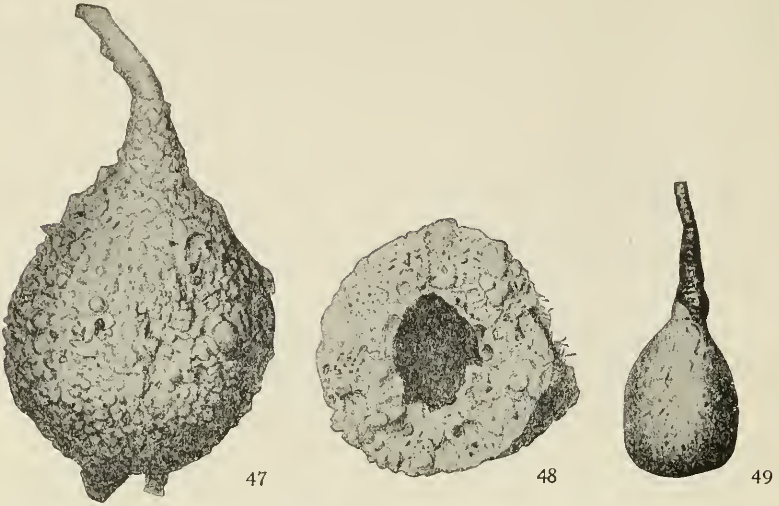
PELOSINA ROTUNDATA H. B. Brady.

Pelosina rotundata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 31, pl. 3, figs. 4, 5; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 236, pl. 25, figs. 18–20.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 254, pl. 11, fig. 60.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 249, pl. 1, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 239, fig. 71 (in text).

Description.—Test flask-shaped or pyriform with an elongated tubular neck, at the end of which is the aperture; wall thick, composed of mud and the tests of other Foraminifera, *Globigernia*, etc., with little cement, the tubular neck membranaceous, interior consisting of a single undivided chamber, small; color grayish white.

Diameter 1.8 mm.

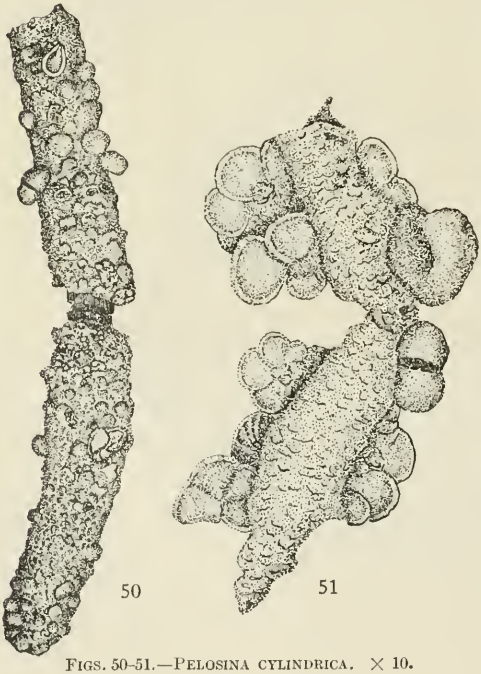
Distribution.—The *Challenger* dredged this species at station 246, in 2,050 fathoms in the middle of the North Pacific. This is the only record for this area, although it was found by Millett in material from the Malay Archipelago. It has usually been found in rather deep water.



Figs. 47-49.—Pelosina rotundata. × 20 (after Brady). 48, transverse section.

PELOSINA CYLINDRICA H. B. Brady.

Pelosina cylindrica H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 236, pl. 26, figs. 1-6.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 253, pl. 4, figs. 1, 2.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 239, fig. 72 (in text).



Figs. 50-51.—Pelosina cylindrica. × 10.

Description.—Test elongate, cylindrical, straight or slightly curved, of nearly uniform diameter, ends rounded, aperture at one end, circular; wall thick, composed of loosely aggregated shell fragments or foraminiferal tests with a mud base, outside irregular, rough, interior smoothly finished, interior chitinous; color dark gray, but varying much according to the constituents of the test, being almost white when many foraminiferal tests are included in the wall.

Length up to 12 mm.; diameter about 2 mm.

Distribution.—The *Challenger* expedition obtained this species at three North Pacific stations, 237, 244, 246, in

1,875–2,900 fathoms. These stations are in the deep portion of the western Pacific, the first of the stations off the east coast of Japan.

The only *Albatross* material I have seen which may be referred to this species is a portion of the specimens selected by Goës from *Albatross* station D3375, in 1,201 fathoms, in the eastern tropical Pacific. These were all called by Goës *Rhizammina indivisa*, but some of them evidently belong here.

PELOSINA VARIABILIS H. B. Brady.

Pelosina variabilis H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 30, pl. 3, figs. 1–3; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 235, pl. 26, figs. 7–9.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 266, pl. 4, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 239, fig. 74 (in text).

Description.—Test consisting of a single fusiform chamber, or of two or three independent chambers, irregularly associated, but usually at the apertural end of the first chamber; wall thick, composed of mud and some foreign particles loosely aggregated, the basal layer being chitinous, apertural end somewhat extended into a tubular neck, the wall of which is membranaceous, at its end a circular aperture, chamber within conforming to the shape of the test; color gray.

Diameter at widest portion about 2 mm., length 18–20 mm.

Distribution.—In the North Pacific this species is known only from a single *Challenger* station, 246, in 2,050 fathoms, situated in the deep portion of the middle part of the North Pacific.

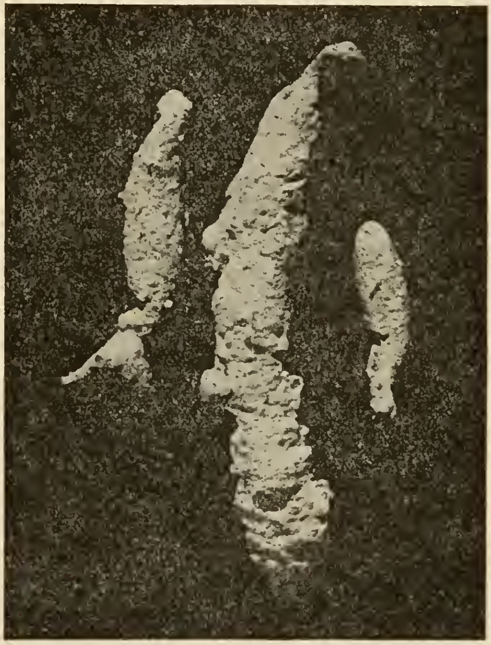


Fig. 52.—Pelosina variabilis. × 20 (after Flint).

Genus TECHNITELLA Norman, 1878.

Technitella Norman (type, *T. legumen* Norman), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 279.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 245.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 256.

Description.—Test free, usually elongate, subcylindrical, fusiform or elongate-oval, interior consisting of a single chamber; wall thin, composed of sponge spicules and fine sand, aperture rounded, single, at one end of the test.

Two species of *Technitella* are known from the North Pacific, and they both seem to be very rare. The genus is at once distinguished by the elongate arrangement of the sponge spicules in the direction of the long axis of the test.

TECHNITELLA LEGUMEN Norman.

Technitella legumen NORMAN, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 279, pl. 16, figs. 3, 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 246, pl. 25, figs. 8-12.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 14, pl. 3, figs. 20-27.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 251, pl. 4, fig. 4.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 256, fig. 96 (in text).

Description.—Test subcylindrical, frequently somewhat curved, apertural end rounded or sometimes with a short tubular neck, aboral end rounded or sometimes bluntly pointed; wall composed of sponge spicules and sand grains, aperture rounded; color of test white or grayish white, sometimes with a coating of sand.

Length up to 2.5 mm.

Distribution.—Known from station 237 of the *Challenger* expedition, east of Japan, in 1,875 fathoms.

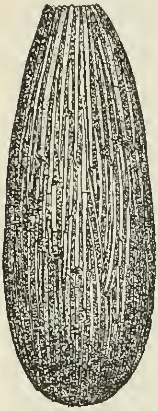


FIG. 53.—TECHNITELLA LEGUMEN. × 50.

TECHNITELLA MELO Norman.

Technitella melo NORMAN, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 280, pl. 16, figs. 5, 6.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 246, pl. 25, figs. 7 *a*, *b*.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 12.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 256, figs. 95 *a*, *b* (in text).

Description.—Test oval, being slightly tapering at the ends, aperture small, usually circular, at one end of the test; wall composed almost entirely of long sponge spicules arranged lengthwise of the test firmly united with a white cement; color white or grayish white.

Length, 1.4 mm.; diameter, 1.0 mm.

Distribution.—There is but the one North Pacific *Challenger* record for this species, station 237, east of Japan, in 1,875 fathoms.

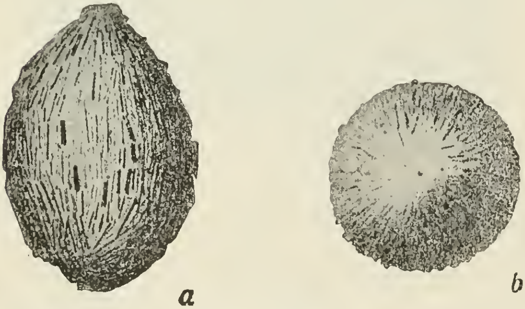


FIG. 54.—TECHNITELLA MELO. × 50 (AFTER BRADY). *a*, SIDE VIEW; *b*, APERTURAL VIEW.

Genus THOLOSINA Rhumbler, 1895.

Placopsilina H. B. Brady (part), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 51; vol. 21, 1881, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 314.

Tholosina Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82; Arch. Protistk., vol. 3, 1903, p. 226.

Pseudoplacopsilina Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 672.

Description.—Test attached, hemispherical, flattened on the side by which it is attached, chamber single, undivided; walls fairly thick, composed of sand grains with a large proportion of calcareous cement, walls roughened on the exterior.

The single species of this genus has been found but rarely in the North Pacific. It is easily distinguished when it is attached to dark colored tests like *Rhabdammina*, as its white color shows up strikingly against the darker background.

Rhumbler seems to be quite right in making a new genus for this species, which is quite different from the genus to which it has usually been assigned. The name proposed by Eimer and Fickert will have to go into the synonymy and the earlier name proposed by Rhumbler will stand.

THOLOSINA BULLA (H. B. Brady).

Placopsilina bulla H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 315, pl. 35, figs. 16, 17.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 28, pl. 6, figs. 213–215 (not figs. 211, 212=*Ammolagena*); Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25.—Millett, Journ. Roy. Micr. Soc., 1899, p. 361, pl. 5, fig. 11.

Tholosina bulla Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82.—Kiær, Norske Nordhavs-Exp., No. 25, 1899, p. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 227, fig. 52 (in text).

Pseudoplacopsilina bulla Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 672.

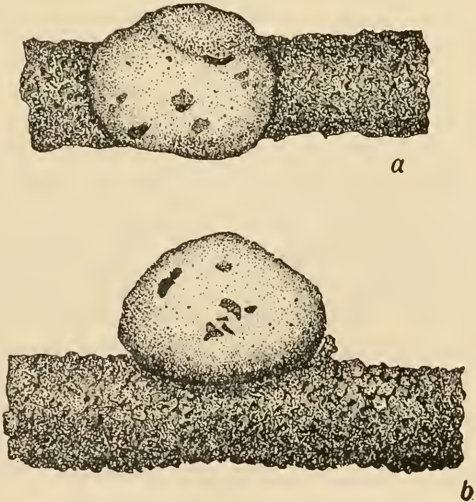


Fig. 55.—Tholosina bulla. × 15. *a*, from above; *b*, from side.

Description.—Test adherent hemispherical or strongly convex, flattened at the base to conform to the surface to which it is attached, usually slightly longer in one direction than the other; chamber single, usually undivided, walls thick, composed of sand grains with an excess of calcareous cement, surface uneven, apertures simple, nearly circular, usually two in number, situated at either end near the base; color grayish white.

Diameter 0.5–1.0 mm.

Distribution.—The only published records for this species in the North Pacific are those of Goës, *Albatross* station D3399, in 1,740 fathoms off Panama and station D3419, in 772 fathoms off the west coast of Mexico. I have examined the material selected by Goës, consisting of five specimens attached to *Rhabdammina* and *Saccammina.* One of these specimens is figured here. This shows a slight tendency toward division as do certain other specimens. Goës[a] shows a longitudinal section of a specimen indicating a division into three chamberlets. Figures 211 and 212 referred to this species by Goës are really *Webbinella hemisphærica* (Jones, Parker, and H. B. Brady).

I have found a single specimen from Blake Reef, south of Japan, *Albatross* station H4881, 316 fathoms, which seems to be an immature specimen of this species. It is attached to a fragment of shell, slightly less convex than larger specimens, but otherwise similar. Another single specimen was found from *Albatross* station D5056, in 258 fathoms on the east coast of Japan, attached to a specimen of *Bathysiphon filiformis.* A third single specimen is from D4979 off Japan attached to a specimen of *Rhabdammina.*

Genus WEBBINELLA Rhumbler, 1903.

Webbina Jones, Parker, and H. B. Brady, Pal. Soc. Monogr., 1865, p. 27 (not *Webbina* d'Orbigny, 1839).—H. B. Brady (part), Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 348.—Chapman, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 326.

Psammosphæra Eimer and Fickert (part), Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.

Webbinella Rhumbler (part), Arch. Protistk., vol. 3, 1903, p. 228.

Description.—Test adherent, circular in outline, the central portion convex, the peripheral portion often forming a flattened rim about the central portion; chamber single, undivided, wall of medium thickness, composed of sand grains with much cement, aperture not apparent, the pseudopodia being thrust out at the basal portion of the test near the line of its attachment.

The genus *Webbinella* as thus amended will exclude *Webbinella clavata* (Jones and Parker), which is placed in the genus *Ammolagena,* which seems very distinct. *Webbinella* as here understood contains the single species described below.

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[a] Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, pl. 6, fig. 215.

WEBBINELLA HEMISPHÆRICA (Jones, Parker, and H. B. Brady).

Webbina hemisphærica JONES, PARKER, and H. B. BRADY, Pal. Soc. Monogr.. 1865, p. 27, pl. 4, fig. 5.—ROBERTSON, Rep. Brit. Ass., 1875, p. 189:—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 350, pl. 41, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 266, pl. 14, figs. 1-3.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 24.

Placopsilina bulla GOËS (part), Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 28, pl. 6, figs. 211, 212 (not figs. 213-215).

Psammosphæra hemisphærica EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.

Webbinella hemisphærica RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 228, fig. 54 (in text).

Description.—Test adherent, circular in outline when seen from above, central portion convex, surrounded by a flattened border of varying width, chamber single, undivided, wall composed of sand grains with much cement, nearly smooth outside, more or less roughened within; aperture not visible, the region of attachment serving for the egress of the pseudopodia about its edge; color grayish-white or brownish.

Diameter 0.5–1.5 mm.

Distribution.—The two specimens which I have found in the *Albatross* material from the Northwest Pacific are the only records for this region. Single specimens attached to shell fragments were found, one at *Albatross* station D4874, in 66 fathoms in Korea Strait, near Japan, the other at D4900, in 139 fathoms in the Eastern Sea of Japan.

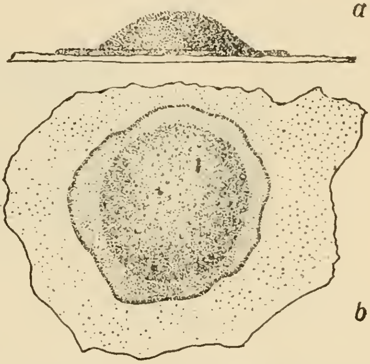


FIG. 56.—WEBBINELLA HEMISPHÆRICA, ATTACHED TO A FRAGMENT OF SHELL, × 50. *a*, FROM SIDE; *b*, FROM ABOVE.

Genus AMMOSPHÆROIDES, new genus.

Description.—Test irregularly subglobular, composed of an elongate or subspherical chamber with double apertures typically; wall finely arenaceous with a large proportion of reddish-brown cement, apertures at the end of short tubular portions of the test.

Type of the genus.—*Ammosphæroides distoma*, new species.

The peculiar rusty appearance of the test and the double apertures at once separate this from any allied arenaceous forms.

AMMOSPHÆROIDES DISTOMA, new species.

Description.—Test irregular, subglobular or with deep depressions of the surface, irregularly made up of two portions, each of which possesses an aperture; wall finely arenaceous, the outer portion flaking off when specimens are dried, fairly smooth, with an abundance of cement of a dark reddish-brown color; apertures at the end of very short tubular necks, irregular or nearly circular in section; color ferruginous, due to the dark reddish-brown color of the cement.

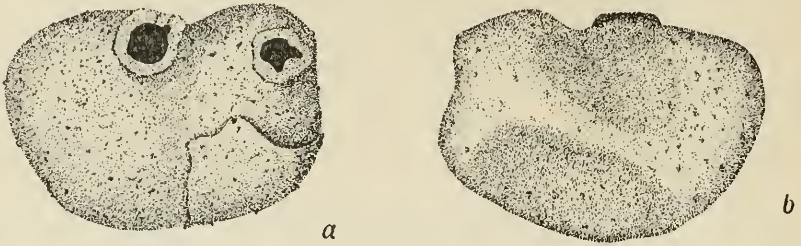


FIG. 57.—AMMOSPHÆROIDES DISTOMA. × 50. *a*, APERTURAL VIEW; *b*, FROM SIDE.

Diameter 0.4–0.8 mm.

Distribution.—Specimens of this species were fairly common at one *Albatross* station, D5018, in the sea of Okhotsk off the southern end of the eastern coast of Sakhalin Island, in 82 fathoms.

Type-specimen.—No. 8258, U.S.N.M., from the above station.

Genus VERRUCINA Goës, 1896.

Verrucina Goës (type, *V. rudis* Goës), Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 232.

Description.—Test adherent, irregular-ovoid in shape; interior divided into irregular chamberlets, wall composed of sand grains, rough externally, aperture usually double, situated in the depressed area at the center of the dorsal side.

This genus of Goës contains a single species.

VERRUCINA RUDIS Goës.

Verrucina rudis Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25, pl. 1, figs. 15, 16.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 233, fig. 62 (in text).

Description.—Test adherent to *Rhabdammina*, the basal portion spreading over the surface of the tube, the other portion rising up into an irregular-ovoid shape, top flat, depressed in the center, cavity a single chamber divided irregularly into chamberlets, wall fairly thick, aperture single, but usually double at the bottom of the sunken area, color dark gray.

Length averaging about 2 mm.

Distribution.—Known only from the type station, *Albatross* station D3419, off the west coast of Mexico in 772 fathoms. I have examined the five specimens in the material selected by Goës as well as a few other specimens found in the original material from this station. Some of the specimens are much higher than is shown either in Goës's figure or in our figure. One specimen is somewhat higher even than the length of the base. With this exception the characters seem to be rather constant in the specimens examined.

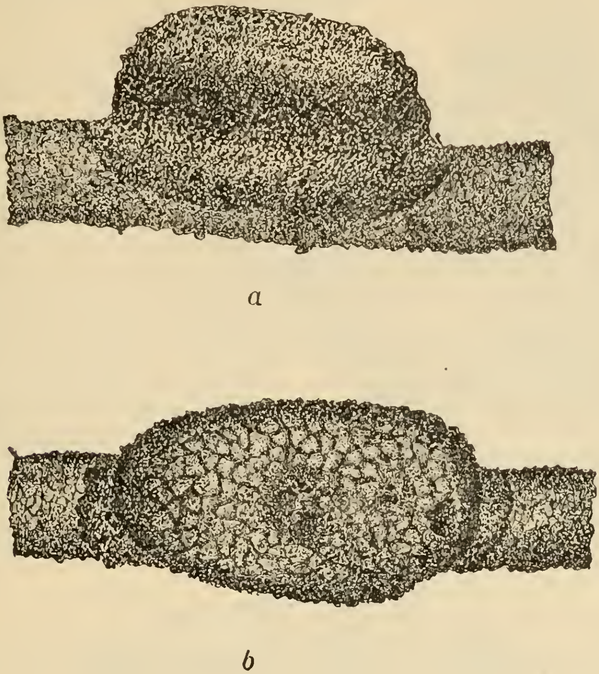


FIG. 58.—VERRUCINA RUDIS. × 10. *a*, SIDE VIEW; *b*, VIEWED FROM ABOVE.

Genus CRITHIONINA Goës, 1894.

Crithionina Goës (type, *C. mamilla* Goës) Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 14; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 229.

Description.—Test spherical, lenticular, or variously shaped, interior either labyrinthic or with a single chamber, apertures small and scattered or indistinct, wall thick, composed of sponge spicules or very fine sand, often chalky in appearance.

This genus which has a considerable development in the Arctic and North Atlantic oceans seems to find similar conditions off the western coast of North America where several species occur. They seem in most cases to be specifically distinct from the Atlantic and Arctic forms. Four species occur off the west coast of America.

CRITHIONINA RUGOSA Goës.

Crithionina rugosa Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24, pl. 2, figs. 3, 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 232, fig. 59 (in text).

Crithionina abyssorum (part) Kiær, Norske Nordhavs-Exp., no. 25, 1899, p. 7, pl. 1, fig. 4 (not 1–3).

Description.—"Subglobular, with coarsely tuberculated surface; wall thick, obsoletely cavernous, the chamber somewhat irregular, showing faint traces of subdivision; color gray or whitish; the consistency of the shell is usually loose, the texture being finely arenaceous, with a large portion of shell débris. Diameter 1–2 mm."

Distribution.—Goës found and described this species from material from two *Albatross* stations D3415, in 1,879 fathoms off the west coast of Mexico and D3407, in 885 fathoms, near the Galapagos Islands.

The above description is copied from that of Goës. His specimens from the first of the two stations I have examined. There are six, rather poorly characterized specimens, more irregular than his figure. One of these specimens is figured here.

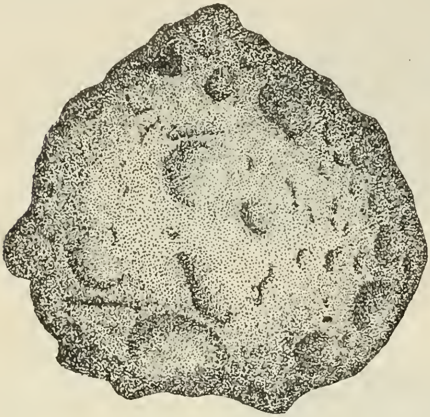


FIG. 59.—CRITHIONINA RUGOSA. × 20.

CRITHIONINA LENS Goës.

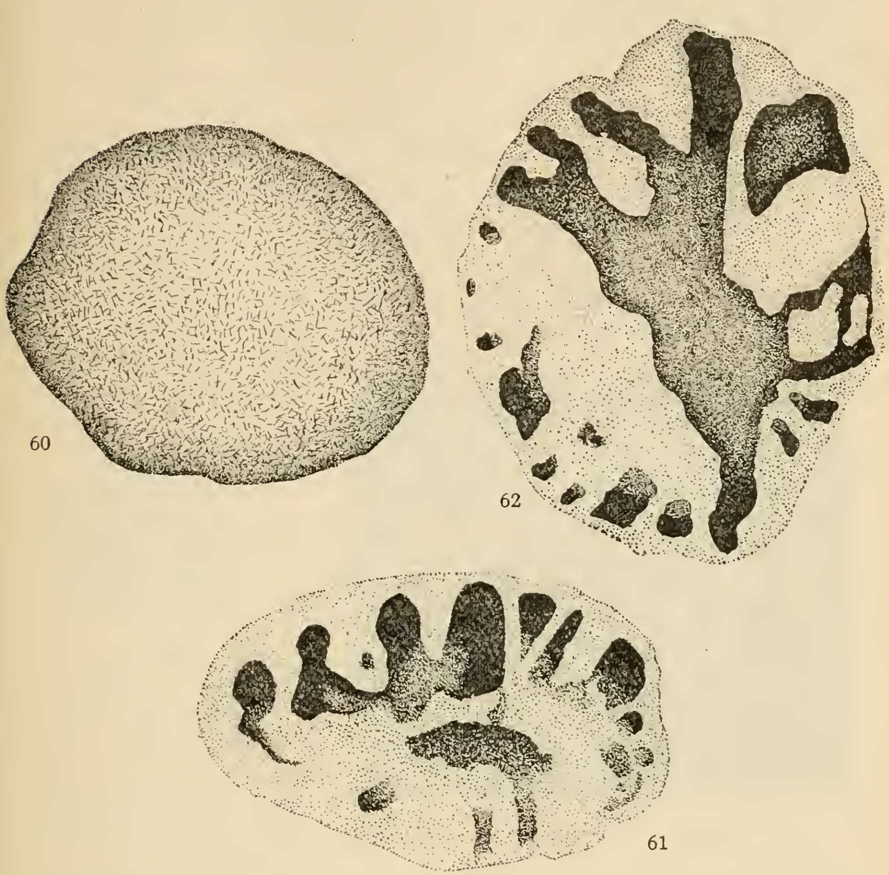
Crithionina lens GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24, pl. 2, figs. 5–8.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 232, fig. 60 (in text).

Description.—Test flattened, orbicular, elliptical or irregular in outline, thickest in the middle, giving a lens form to the test as a whole; interior with a central chamber and many large radial chamberlets irregular in number, size and shape, central cavity sometimes indistinct or obsolete; wall thick, composed of sponge spicules and fine amorphous matter with very fine sand; color light gray, often almost white.

Diameter 2–4 mm.

Distribution.—Goës records this species from three stations in the eastern tropical Pacific, one off Acapulco, Mexico, another south of Panama, the third near the Galapagos Islands, *Albatross* stations D3376, D3407, D3419, in 772–1,132 fathoms. This is the only region where this species has been met with. I have found a single poor specimen from station D4334, off San Diego, California.

A number of specimens selected by Goës have been examined, and I fail to find any such regularity in the divisions as shown by Goës's figures. In the accompanying figures are given two sections from Goës's material from station D3419.



FIGS. 60–62.—CRITHIONINA LENS. 60, SURFACE VIEW. × 15. 61, VERTICAL SECTION. × 20. 62, HORIZONTAL SECTION. × 20.

CRITHIONINA PISUM Goës.

Crithionina pisum GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24, pl. 2, figs. 1, 2.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 250, pl. 4, fig. 3.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 266, pl. 6, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 242, fig. 57 (in text).

Crithionina abyssorum (part) KIÆR, Norske Nordhavs-Exp., no. 25, 1899, p. 7, pl. 1, fig. 2 (not 1, 3, 4).

Description.—Test free, globular in typical form but variable, surface even, wall rather thick, soft, composed of loosely-matted sand

and sponge spicules, interior chamber single, undivided, apertures interstitial; color grayish white.

Diameter 1–3 mm.

The typical form of this species has not been recorded from the North Pacific, but it is represented by the following variety:

CRITHIONINA PISUM Goës, var. HISPIDA Flint.

Crithionina pisum Goës, var. *hispida* Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 267, pl. 6, fig. 2.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 230, fig. 61 (in text).—[?] Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 127.

Crithionina abyssorum (part) Kiær, Norske Nordhavs-Exp., no. 25, 1899, p. 7, pl. 1, figs. 1, 3 (not 2, 4).

Description.—Variety differing from the typical in its smaller size and the hispid surface made up of a great number of sponge spicules arranged nearly perpendicular to the outer wall; walls somewhat thinner than in the typical.

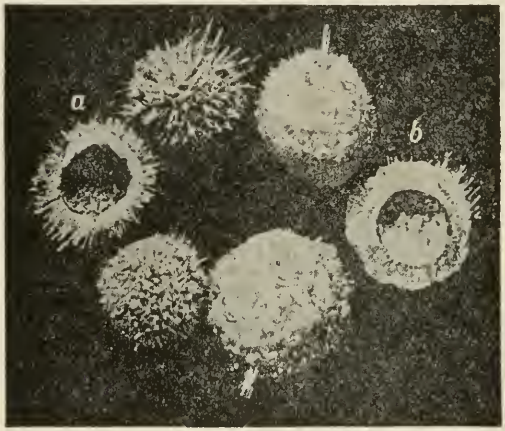


Fig. 63.—Crithionina pisum, var. hispida. × 15 (after Flint). *a*, *b*, sections.

About one-half the size of the typical form.

Distribution.—One of the original stations for Flint's material was in the North Pacific, *Albatross* station D3080, in 93 fathoms, green mud, off Hecata Bank, Oregon. Bagg records the variety from two *Albatross* stations, H4440, in 1,259 fathoms, and H4502, in 1,342 fathoms, both stations in the vicinity of the Hawaiian Islands. I have failed to find this variety in any of the western Pacific material that I have examined.

The specimens from *Albatross* station H4502 in the National Museum labeled as this variety by Doctor Bagg seem to me to be very small spinose Radiolaria and not Foraminifera. The largest one measures but 0.05 mm. without the spines.

The figure given here is from the original of Doctor Flint.

CRITHIONINA ROTUNDATA, new species.

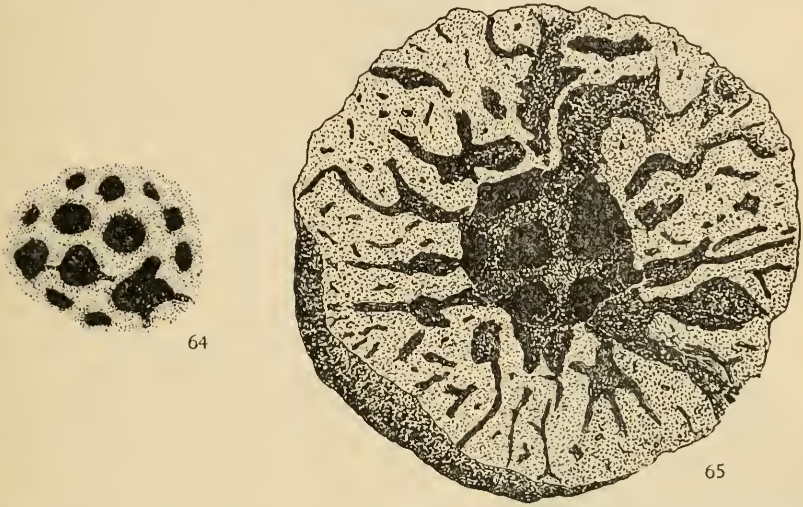
Description.—Test free, subspherical, composed of loosely agglutinated sand grains; surface with many pores leading by canals through the thick walls to the single central chamber, which is simple, nearly spherical, and small compared to the size of the test; wall of the chamber with many circular or roughly polygonal openings which ramify into the canals leading to the surface; wall of the central chamber and canals firmer than the rest of the test, usually showing in these firmer portions a reddish-brown cement; color dark grayish brown.

Diameter 3–6 mm.

Distribution.—Specimens of this species were common in the material from *Albatross* station D4327, off San Diego, Cal., 263–330 fathoms.

Type-specimen.—Cat. No. 8259, U.S.N.M.

This species is perhaps nearest to *Crithionina rugosa* and *C. mamilla* Goës. It is very much larger than either of those species and has a more definite structure. *C. mamilla* is an attached form of small size. *C. rugosa* is also a small, subspherical species. I have examined the original specimens of *C. rugosa* selected by Goës from the type station, and they are all small and largely made up of white, finely granular material of an entirely different appearance from this species. This is by far the largest species yet known in this genus.



FIGS. 64–65.—CRITHIONINA ROTUNDATA. 64, PORTION OF CENTRAL CHAMBER WALL. × 25. 65, VIEW OF SECTIONAL SPECIMEN SHOWING THICK WALL AND RADIAL TUBES. × 10.

Genus THURAMMINA H. B. Brady, 1879.

Thurammina H. B. Brady (type, *T. papillata* H. B. Brady), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 45.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 202.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 321.

Thyrammina Rhumbler, Arch. Protistk., vol. 3, 1903, p. 236.

Lituola W. B. Carpenter (part), The Microscope, 5th ed., 1875, p. 533.

Description.—Test typically free, usually nearly spherical, but in some species compressed, chamber single and undivided in typical species; wall thin, composed of fine sand with more or less chitin; apertures several to many at the end of nipple-like protuberances of the surface, occasionally wanting.

Two species occur rarely in the North Pacific; the third species, described by Goës, does not seem to be a Foraminifer as far as can be made out by a study of Goës's material.

THURAMMINA PAPILLATA H. B. Brady.

"*Orbuline Lituola*" W. B. Carpenter, The Microscope, 5th ed., 1875, p. 533, fig. 273 *g*, *h*.

Thurammina papillata H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 45, pl. 5, figs. 4–8.—W. B. Carpenter, The Microscope, 6th ed., 1881, p. 561, fig. 320 *g*, *h*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 321, pl. 36, figs. 7–18.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 263, pl. 5, fig. 9.—Chapman, Proc. Zool. Soc. London, 1895, p. 17.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 278, pl. 22, fig. 1.

Thyrammina papillata Rhumbler, Arch. Protistk., vol. 3, 1903, p. 238, fig. 68*a–c* (in text).

Description.—Test usually free and rounded, occasionally adherent, the lower surface being adapted to the shape of the object to which it is adherent; usually a single chamber, but occasionally another chamber is found within the outer one; wall very thin, composed of small sand grains very neatly cemented with a reddish-brown cement, giving the whole test a reddish brown color; apertures numerous, variable, situated at the ends of nipple-like projections of varying length.

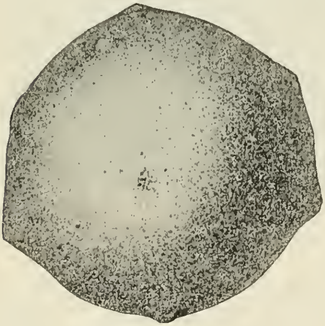


Fig. 66.—Thurammina papillata. × 30 (after Brady).

Diameter 0.4–1.6 mm.

Distribution.—All that is known of this species in the North Pacific is from the *Challenger* dredgings, stations 237, 246, 253, 269, in 1,875, 2,050, 3,125, and 2,550 fathoms, respectively. The first of these stations is a short distance east of Japan, the others in the deep water of the mid-Pacific. It also occurred at station 271, just south of the equator, in 2,425 fathoms.

From the figures and description there is evidently more than one thing now included under this specific name, but more material is necessary to be sure of this.

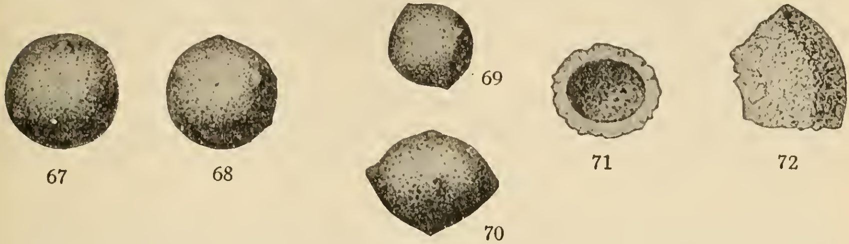
THURAMMINA ALBICANS H. B. Brady.

Thurammina albicans H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 46; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 323, pl. 37, figs. 2–7.

Thyrammina albicans Rhumbler, Arch. Protistk., vol. 3, 1903, p. 237, fig. 67 (in text).

Description.—"Test spherical, or nearly so; with few, usually about six, mammillate orifices, equidistant and regularly disposed. Walls somewhat thicker than those of the type [*T. papillata*]; texture very finely arenaceous; color nearly white. Diameter about $\frac{1}{90}$th inch (0.28 mm.)."

Distribution.—Brady does not definitely record this species from the North Pacific in volume 9 of the *Challenger* Report, but in the second part of the volume on the "Summary of Results," this species is recorded on page 965, from station 246, 2,050 fathoms in the middle of the North Pacific.



Figs. 67-72.—Thurammina albicans. 67-70, side views. × 50. 71, section showing thickness of wall and character of the interior. × 50. 72, section of test showing minute structure, × 100 (figs. after Brady).

The description and figures are from Brady.

THURAMMINA ERINACEA Goës.

Thurammina erinacea Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 26, pl. 2, figs. 9, 10.

Thyrammina erinacea Rhumbler, Arch. Protistk., vol. 3, 1903, p. 237, fig. 66 *a*, *b*, (in text).

I have examined the material selected by Goës as belonging to this species and am inclined to think that they are Radiolaria and not Foraminifera at all. Radiolaria of this form and size are not uncommon on both sides of the Pacific. The mounted specimens are fastened to a strip of cardboard and are not easily examined, but some of the specimens are plainly Radiolaria.

Goës recorded this species from nine *Albatross* stations along the west coast of Mexico and Central America in 557–1,879 fathoms.

Subfamily 3. HYPERAMMININÆ.

Test consisting of a globular proloculum and a more or less elongated, sometimes branching portion, but not divided into chambers; free or attached, wall of various agglutinated materials.

In this subfamily are included a number of genera with the above characters common to all. The main distinction between such genera as *Hyperammina*, *Botellina*, *Ammolagena*, etc., seems to be in the material of the test and the habit of growth rather than in essential differences in the general form of the test. All are of agglutinated material. In *Sagenina* the test is very much branched, sometimes anastomosing, but in essential features other than its excessive branching seems to belong with the others of this family.

Genus HYPERAMMINA H. B. Brady, 1878.

Rhabdopleura? Dawson, Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86.

Hyperammina H. B. Brady (type, *H. elongata* H. B. Brady), (part), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 193.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 257.—Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82; Arch. Protistk., vol. 3, 1903, p. 257.

Hyperammina+Bactrammina Eimer and Fickert, Zeitschr. wiss. Zool., vol 65, 1899, pp. 673, 675.

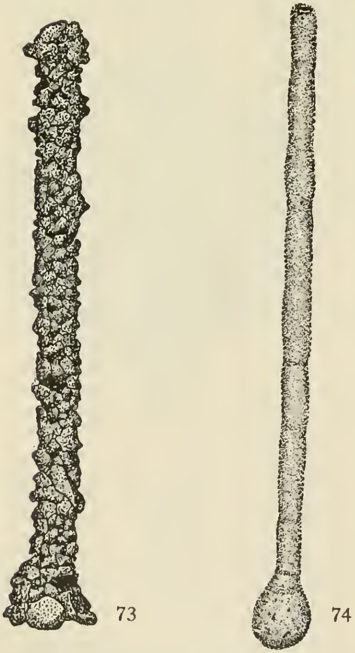
Description.—Test free, elongate, in general a simple cylindrical tube with a swollen proloculum at the proximal end, the distal end open and serving as the aperture, wall composed of sand grains, interior usually smoothly finished.

There are several species of *Hyperammina* in the North Pacific, but in general they are the species that are also known from other ocean basins. In general they are found in cool water and often at considerable depths.

HYPERAMMINA ELONGATA H. B. Brady.

Hyperammina elongata H. B. Brady (part), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433, pl. 20, figs. 2 *a*, *b;* Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 98.—Balkwill and Wright, Proc. Roy. Irish Acad., vol. 3, 1882, p. 546.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 257, pl. 23, figs. 4, 7 (not 9, 10).—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 17, pl. 4, figs. 56–58 (not 55).—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 22.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 10, fig. 2 (part).—Kiær, Norske Nordhavs-Exp., no. 25, 1899. p. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 258, figs. 98 *a*, *b*, (in text).

Bactrammina elongata Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 673.



Figs. 73–74.—Hyperammina elongata. 73, test of comparatively large sand grains, from shallow water. × 15. 74, test of fine material from deeper water. × 12.

Description.—Test elongate, consisting of a long tubular portion of small diameter, composed of sand grains, proloculum broadly rounded, usually considerably larger than the diameter of the tube, wall usually consisting of but a single layer of sand grains with a varying amount of cement, smooth on the interior surface, rougher on the exterior; aperture at the distal end of the tube, little if at all constricted; color gray, sometimes brown, depending largely upon the color of the sand grains.

Diameter about 0.5 mm.; length up to 8 mm.

Distribution.—This species seems to be well distributed in the North Pacific. The *Challenger* records note it but twice in this region, in the abyssal region at 2,300 and 3,125 fathoms. Goës records it from two stations in the southeast portion of the region, *Albatross* stations D3375, 1,201 fathoms, and D3407, 885 fathoms.

I have records of its occurrence at about twenty *Albatross* and *Nero* stations in 110–2,848 fathoms. These stations are off California, near Hawaii, several near the Bonin Islands, five on the southeast coast of Japan, and two in Bering Sea.

Specimens of this species are usually without the proloculum, but a number of specimens in the present series show the complete test. It is of sand grains, coarse for the size of the tube as a rule, and the proximal end is broad and almost flattened in some cases. It is rather distinct from the following variety, although the two have been found in company with one another at one station.

HYPERAMMINA ELONGATA H. B. Brady, var. LÆVIGATA J. Wright.

Hyperammina elongata H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884. p. 257, pl. 23, figs. 9, 10 (not 3, 7, 8).—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 17, pl. 4, fig. 55 (not 56–58).—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 10, fig. 2 (in part).—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 258 (in part).

Hyperammina elongata H. B. Brady, var. *lævigata* J. Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 466, pl. 20, fig. 1.

Description.—Variety differing from the typical in its smooth test, great excess of cement, color yellowish or reddish brown, and the proloculum ovoid, somewhat fusiform in shape, but little larger in diameter than the tube but with somewhat of a constriction where it unites with the tube; usually of smaller size than the typical form.

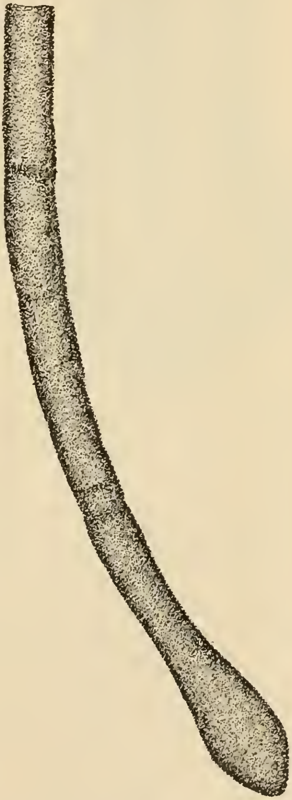


Fig. 75.—Hyperammina elongata, var. lævigata. Specimen from *Albatross* station D4979, off Japan. × 40.

Distribution.—Apparently more rare in the North Pacific than the typical, but not so everywhere. I have found specimens of this variety from *Nero* station 12, in 1,924 fathoms, near the Hawaiian Islands, station 1012, in 1,932 fathoms, north of Guam, and at *Albatross* stations D4970 and D4979, southeast of Japan, in 500 and 743 fathoms. At the last station it occurs with the typical form.

This variety seems to be rather distinct, and should be more definitely recorded, as it has certain characters of more than varietal rank, but it is kept here for the present.

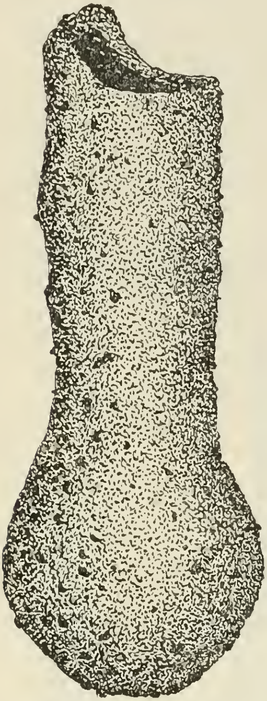


FIG. 76.—HYPERAMMINA FRIABILIS. SPECIMEN WITH THE UPPER PORTION OF THE TUBE BROKEN AWAY. × 50.

HYPERAMMINA FRIABILIS H. B. Brady.

Hyperammina elongata H. B. BRADY (part), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 32.

Hyperammina friabilis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 258, pl. 23, figs. 1-3, 5, 6.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 17, pl. 4, fig. 59; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 22.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 269, pl. 10, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 258, fig. 99 *a*, *b*, in text.

Description.—Test elongate, subcylindrical, or tapering somewhat toward the distal end, nearly straight, test composed of coarse sand grains, wall thick and loosely cemented, exterior roughened, interior rather smooth, proximal end closed, forming a nearly spherical proloculum from which the elongated tubular portion originates, not always distinct from the exterior; aperture at the distal end small, nearly circular; color gray, often reddish-brown about the aperture and on the inner parts of the wall where there is more cement.

Diameter 2 mm., length up to 15–16 mm.

Distribution.—I have found specimens apparently of this species from four North Pacific stations: *Albatross* station D2806 in 1,329 fathoms near the Galapagos Islands, station D3608 from Holothurian stomachs; from Bering Sea, 279 fathoms; and at *Nero* station 1528, east of Guam, in 2,391 fathoms. A single specimen was found at *Albatross* station H4014, in 3,800 fathoms, the deepest record for this species. One specimen was found from *Albatross* station D4334, off California.

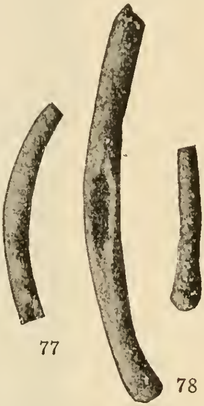
HYPERAMMINA MAXIMA, new species.

Description.—Test elongate, straight or slightly curved, large, composed of a swollen proloculum and an elongate tubular chamber; wall thick, composed of sand grains and sponge spicules, rather loosely cemented, aperture rounded, formed by the open end of the tube; color gray or light brownish-gray.

Length up to 40 mm., diameter 2 mm.

Type-specimen.—Cat. No. 8211, U.S.N.M., from *Albatross* station D4337, off California.

This species is much larger than any of the others of the genus. Its walls have a large proportion of sponge spicules. At the type station this species occurred in great quantities with other arenaceous species.



FIGS. 77–79.—HYPERAMMINA MAXIMA. × 2. FROM PHOTOGRAPH.

HYPERAMMINA SUBNODOSA H. B. Brady.

Rhabdopleura, species, G. M. DAWSON, Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86, fig. 7.

Hyperammina subnodosa, H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 259, pl. 23, figs. 11–14.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 255, pl. 4, fig. 32.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 16, pl. 3, figs. 42–53 (not 54).—SCHLUMBERGER, Mém. Soc. Zool. France, vol. 7, 1894, p. 254.—RHUMBLER, Arch. Protistk, vol. 3, 1903, p. 259, fig. 100 *a*, *b* (in text).

Description.—Test elongate, subcylindrical, comparatively large, proximal end enlarged into a thick-walled proloculum, tube constricted at intervals and with much thicker walls, coarsely arenaceous, aperture at the distal end of the tube, circular; color grayish.

Length up to 18 mm.

Distribution.—This species seems to be rare in the North Pacific. There are five records of its occurrence: *Challenger* stations 237, 241 east of Japan, in 1,875 and 2,300 fathoms; one station in the Okhotsk Sea, recorded by Schlumberger, in 280 meters; one *Albatross* station D5026, also in the Okhotsk Sea but a short distance from the preceding, 119 fathoms; and *Nero* station 1164, near the Bonin Islands, in 2,384 fathoms.

It may be worthy of note that at the shallowest station, *Albatross* station D5026, the bottom temperature in September was 30.4° F., even colder than at the abyssal stations where the species was found.

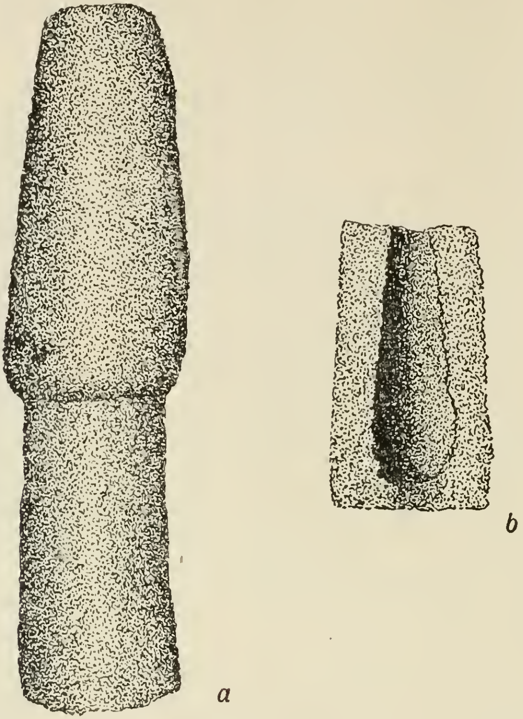


FIG. 80.—HYPERAMMINA SUBNODOSA, FROM THE OKHOTSK SEA × 10. *a*, SIDE VIEW; *b*, SECTION OF A PORTION OF THE CHAMBER LAID OPEN.

Genus SACCORHIZA Eimer and Fickert, 1899.

Hyperammina H. B. BRADY (part), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 257.—RHUMBLER, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82; Arch. Protistk., vol. 3, 1903, p. 257.

Saccorhiza (type, *Hyperammina ramosa* H. B. BRADY), EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 670.

Description.—Test free, consisting of an ovoid proloculum with a branching tube, composed of sand grains with many sponge spicules on the exterior, rough; open ends of the tubes serving as apertures.

This genus has been made for this species, which, in its branching, irregular habit and the almost invariable inclusion of sponge spicules, differs from the typical *Hyperammina*. The genus made by Eimer and Fickert has therefore been used. The other species of Rhumbler, with its inclusions of spicules, has also been included here, although known from but two fragmentary specimens.

SACCORHIZA RAMOSA (H. B. Brady).

Hyperammina ramosa H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33, pl. 3, figs. 14, 15; Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 98; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 261, pl. 23, figs. 15-19.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, no. 7, 1888, p. 217, pl. 41, figs. 1-4, 13.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 255, pl. 4, fig. 15.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 18, pl. 4, figs. 61, 62.—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 22.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 11, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 260, figs. 101 *a*, *b* (in text).

Saccorhiza ramosa Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 670.

Description.—Test free, proloculum ovoid passing into the branched tubular portion, branching irregular, wall fairly thick, composed of sand, more or less coated with sponge spicules exteriorly, rough; apertures at the ends of the tubes, color grayish.

Distribution.—This species seems to be generally distributed in the whole North Pacific, twenty-five or more well scattered stations having been noted. However, none of these records are north of latitude 40° N., but this is probably due to the fact that little material has been available in deep water north of that line.

Complete specimens are very rare, but the fragmentary specimens, which are readily recognized, are common. This species is very different from the typical *Hyperammina* with the single tube and the ordinary sand grains. The investment of sponge spicules shows a selective character rather marked, for they are present on the test even from deep red-clay areas where spicules are not frequent in the same bottom sample in which the tests occur.

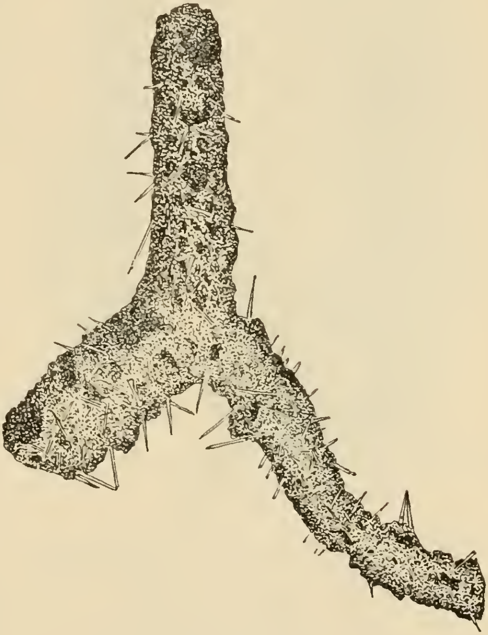


Fig. 81.—Saccorhiza ramosa. × 100.

The figured specimen had very few spicules compared with the majority of specimens.

Specimens were obtained in the cold water off Japan in 39 fathoms, *Albatross* station D4946. The greater number of stations are over 1,000 fathoms, however, the deepest record of its occurrence being 3,125 fathoms.

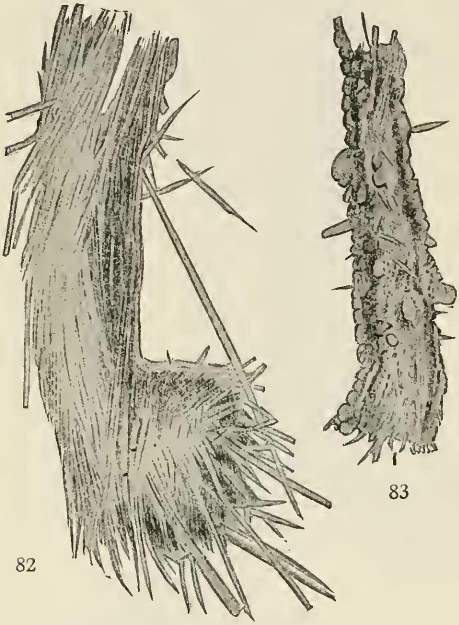
SACCORHIZA CALCILEGA (Rhumbler).

Hyperammina calcilega RHUMBLER, Zool. Jahrb. Abth. Syst., vol. 24, 1906, p. 24, pl. 2, figs. 1, 2.

Description.—Test free, consisting of a nearly spherical proloculum and a tubular portion, wall composed of calcareous sponge spicules and of other foreign calcareous granules; color white.

Length 0.6–0.9 mm., breadth 0.15–0.24 mm.

Distribution.—Two specimens from which Rhumbler described this species were found in shallow water at Laysan. Both are fragmentary specimens of small size, but their characters, especially the sponge spicules, would place the species in the genus *Saccorhiza*, as here considered. The calcareous nature of the foreign matter of the wall is not surprising when the almost universal calcareous nature of coral reef material is considered.



FIGS. 82–83.—SACCORHIZA CALCILEGA. 82, SPECIMEN SHOWING PROLOCULUM. × 115. 83, SPECIMEN SHOWING APERTURAL PORTION. × 60 (AFTER RHUMBLER).

Genus TOLYPAMMINA Rhumbler, 1895.

Hyperammina H. B. BRADY (part), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 260.

Tolypammina RHUMBLER (type, *Hyperammina vagans* H. B. BRADY), Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 83; Arch. Protistk., vol. 3, 1903, p. 276.

Serpulella EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 674.

Description.—Test typically adherent by its under surface, but may become free, consisting of an elongated oval proloculum and long irregular tube, unbranched, composed of sand grains and reddish-brown cement.

Rhumbler has proposed the above genus for the *Hyperammina vagans* of Brady. The attached habit and character of building the test seem sufficient grounds for its separation from others of the species usually assigned to *Hyperammina*. Eimer and Fickert also proposed a generic name for this species, but the name proposed by Rhumbler is several years earlier and is here used.

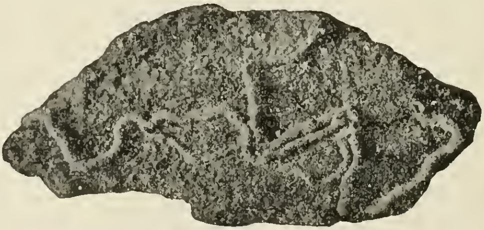


FIG. 84.—TOLYPAMMINA VAGANS. × 10. FROM PHOTOGRAPH.

TOLYPAMMINA VAGANS (H. B. Brady).

Hyperammina vagans H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33, pl. 3, fig. 5; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 260, pl. 24, figs. 1–9.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 11, fig. 2.

Tolypammina vagans Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 83; Zeitschr. allg. Phys., vol. 2, 1902, p. 281, fig. 97; Arch. Protistk., vol. 3, 1903, p. 277, fig. 125 *a*, *b* (in text).

Serpulella vagans Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 674.

Description.—Test typically adherent, consisting of an oval-elongate proloculum and a long irregularly winding tube of rather uniform diameter, unbranched, wall composed of sand grains of small size and united by a reddish-brown cement often in considerable amount, surface rather smooth, color reddish-brown, the proloculum often darker than the tubular portion.

Diameter 0.05–0.2 mm., length 1 mm. or more.

Distribution.—This species occurred at four *Challenger* stations and at eight stations in the *Albatross* and *Nero* material. These are well scattered in the region west of longitude 150° W. and south of latitude 40° N. Most of the stations are over 1,500 fathoms, but it has been noted in shallower water off Japan, *Albatross* stations D4949, in 110 fathoms, D4957 in 437 fathoms. It occurred near the Hawaiian Islands, H2922 in 268 fathoms. The deepest record for this species in the North Pacific is at *Albatross* station H4014, 3,800 fathoms, attached to *Hyperammina friabilis*.

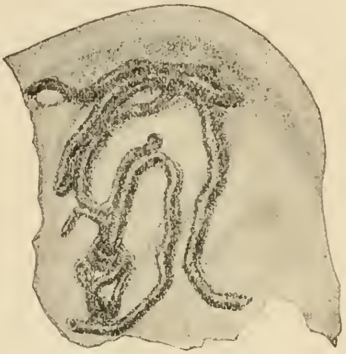


Fig. 85.—Tolypammina vagans. × 15 (after Brady). Proloculum of specimen shown in figure just above the middle.

Genus AMMOLAGENA Eimer and Fickert, 1899.

Trochammina Jones and Parker (part), Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. Carpenter, Parker, and Jones, Intr. Study Foram., 1862, p. 142.

Webbina H. B. Brady (part), Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711 (not *Webbina* d'Orbigny, 1839); Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 349.

Ammolagena Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 673 (type, *Trochammina irregularis*, var. *clavata* Parker and Jones).

Webbinella Rhumbler (part), Arch. Protistk., vol. 3, 1903, p. 229.

Description.—Test adherent, composed of an oval proloculum with a tubular chamber of variable length but of nearly uniform diameter, the open end serving as the aperture; wall finely arenaceous but with an excess of cement, proloculum without a definite floor.

The generic name of this species following should be that proposed by Eimer and Fickert. *Webbina* as used by Brady is not at all the use as proposed by d'Orbigny. Eimer and Fickert proposed the name *Ammolagena* in 1899. Rhumbler includes with this species *Webbinella hemisphærica*, but as *Ammolagena* had already been proposed for it the name of *Ammolagena* Eimer and Fickert should stand and thus the generic name *Webbinella* is left for *Webbinella hemisphærica* in a restricted sense. The two species seem to be very distinct, *Ammolagena clavata* having a proloculum and long tubular chamber with the aperture at the end of the tube. *Webbinella hemisphærica* consists simply of a single adherent chamber with the aperture at the rim of attachment, and there is nothing corresponding to the long tubular portion seen in *Ammolagena clavata*.

The two species seem to be generically distinct and one seems related to the *Hyperammina* group and the other, *Webbinella*, to the single-chambered Saccammininæ.

AMMOLAGENA CLAVATA (Parker and Jones).

Trochammina irregularis, var. *clavata* Parker and Jones, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.

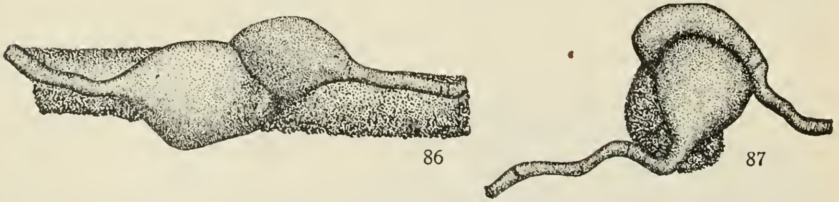
Trochammina irregularis (part), W. B. Carpenter, Parker, and Jones, Intr. Study Foram., 1862, p. 142, pl. 11, fig. 6.

Webbina clavata H. B. Brady, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 349, pl. 41, figs. 12–16.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, pt. 7, 1888, p. 218, pl. 42, fig. 21.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 470, pl. 20, figs. 2, 3.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 32, pl. 6, figs. 245, 246.—Chapman, Proc. Zool. Soc. London, 1895, p. 18.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 35.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 24, fig. 3.—Kiær, Norske Nordhavs-Exp. no. 25, 1899, p. 4.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 129.

Ammolagena clavata Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 673.

Webbinella clavata Rhumbler, Arch. Protistk., vol. 3, 1903, p. 229, fig. 55 (in text).

Description.—Test adherent, consisting of an oval or pyriform proloculum of fairly large size, without a floor, arching upward, thin-walled, and a second tubular chamber of indefinite length, sometimes entirely attached; sometimes the later part free and circular in cross section; wall of fine sand grains, usually with an excess of reddish or yellowish brown cement, smooth; open end of the tube serving as the aperture.



Figs. 86–87.—Ammolagena clavata. × 12. 86, two specimens attached to the surface of a specimen of Rhabdammina. 87, two specimens attached to a coiled arenaceous test. All megalospheric specimens.

Longer diameter of the proloculum 0.5–1 mm.

Distribution.—The only *Challenger* record for this species is found in the volume on "Summary of Results." It is there recorded from station 237, 1,875 fathoms, east of Japan. Brady, in the ninth volume of "the *Challenger* Report," writes that it is a curious fact that he had not met with a single specimen in any of the North Pacific dredgings. In the Eastern North Pacific Goës has recorded this species from three stations off the coast of Mexico and Central America, 660–1,201 fathoms. Bagg records it from six stations in the vicinity of the Hawaiian Islands, 104–978 fathoms. In the present work I have found it from *Albatross* station D3431 where Goës records it, H2999, 549 fathoms, and *Nero* station 2032, 1,014 fathoms, both in the vicinity of the Hawaiian Islands.

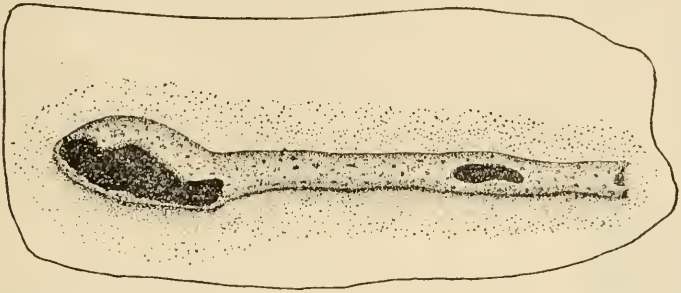


FIG. 88.—AMMOLAGENA CLAVATA. × 50. SPECIMEN ATTACHED, PORTION OF PROLOCULUM BROKEN AWAY. MICROSPHERIC SPECIMEN WITH SMALL PROLOCULUM AND COMPARATIVELY LONG TUBULAR PORTION.

I have examined Goës's selected material and also that selected by Bagg, now in the National Museum.

Besides being attached to pebbles, sand, grains, shells, etc., I have noted its occurrence on the following genera of Foraminifera: *Ammodiscus*, *Cyclammina*, *Rhabdammina*, *Haplophragmium*, *Biloculina*, *Pulvinulina*, and *Cristellaria*.

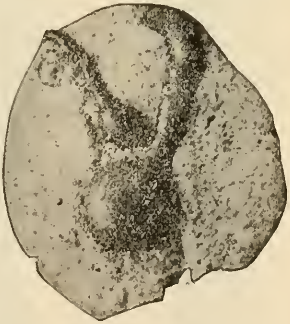


FIG. 89.—AMMOLAGENA CLAVATA. ×15. (FROM PHOTOGRAPH). MICROSPHERIC AND MEGALOSPHERIC SPECIMENS ATTACHED SIDE BY SIDE.

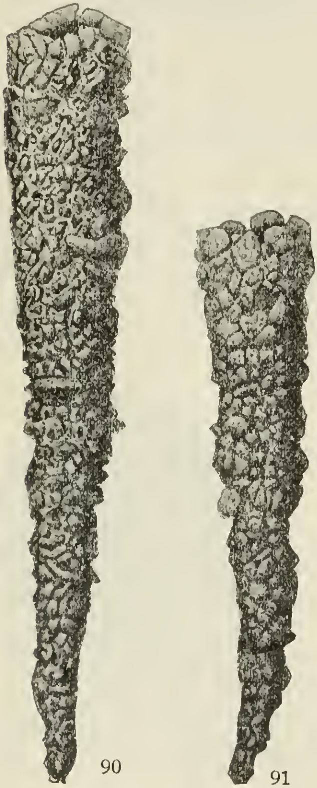
Wright, 1891, speaks of the difference in the length of tube being related to the size of the proloculum, the shorter tube with the larger proloculum, and the reverse. This would indicate a true dimorphism and would correspond to what is known in other groups, that the largest test is usually that with a microspheric proloculum.

Genus JACULELLA H. B. Brady, 1879.

Jaculella H. B. Brady (type, *J. acuta* H. B. Brady), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 35.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 193.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 255.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 273.

Description.—Test free, elongate, conical, widest at the apertural end, opposite end closed; wall thick, composed of sand grains roughly cemented on the exterior.

In *Jaculella* the distinction between proloculum and tubular chamber is not as marked as in some of the other genera, but in *J. obtusa* the relation is often made out more definitely. There are but two described species, both of which are recorded from the North Pacific, though but rarely.



Figs. 90-91.—Jaculella acuta. × 12 (after Brady).

JACULELLA ACUTA H. B. Brady.

Jaculella acuta H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 35, pl. 3, figs. 12, 13.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, no. 4, 1882, p. 143, pl. 12, fig. 432.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 255, pl. 22, figs. 14–18.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 23.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 269, pl. 9, fig. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 273, fig. 122 (in text).

Description.—Test elongate, straight, tubular, proximal end closed and acutely pointed, distal end broader, slightly constricted to form the aperture which is circular, wall thick, composed of coarse sand grains, firmly cemented, exterior rough, proximal end of the test often reddish-brown, distal portion grayish.

Length variable, up to 25 mm. or even more.

Distribution.—Brady records this species at but one North Pacific *Challenger* station, 244, in 2,900 fathoms, in mid-Pacific. I have seen two specimens from *Albatross* station H2684 in 1,122 fathoms and H2917 in 2,615 fathoms, one off the coast of California, the other near the Hawaiian Islands.

The closed end of the specimens seems to be easily detached as they are rarely found complete.

JACULELLA OBTUSA H. B. Brady.

Jaculella obtusa H. B. Brady, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 714; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 256, pl. 22, figs. 19–22.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 20, pl. 4, figs. 87–89; pl. 5, figs. 90, 91; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 23.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 273, fig. 123 (in text).

Description.—Test elongate, straight, tubular, proximal end closed, obtusely rounded, distal end but slightly broader, its open end forming the aperture, wall thick, composed of sand grains, firmly cemented, rough, grayish in color.

Length 10–15 mm.

Distribution.—Known from a single *Challenger* station, No. 237, in 1,875 fathoms, east of Japan. Goës found specimens from *Albatross* station D3407, 885 fathoms, off the west coast of Mexico. I have found numerous other specimens from this latter station and have a few specimens from Bering Sea, *Albatross* station D3501, in 688 fathoms.

This species is often nearly cylindrical or wider in the middle than at either end, the texture rather less firm than is that of *J. acuta*.

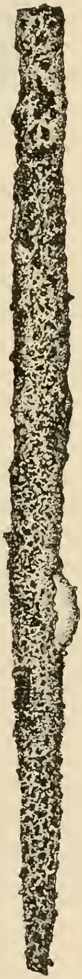


Fig. 92.—Jaculella obtusa. × 15.

Genus SAGENINA Chapman, 1900.

Sagenella H. B. Brady (type, *S. frondescens* H. B. Brady), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 41; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 278 (not *Sagenella* Hall).

Sagenina Chapman, Journ. Linn. Soc., vol. 28, 1900.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 221.

Description.—Test attached, tubular, dichotomously or irregularly branching, often anastomosing; wall arenaceous; apertures at the ends of the branches.

This genus contains several species, all occurring as far as known in the eastern seas and in tropical waters or in some cases subtropical as well.

SAGENINA FRONDESCENS (H. B. Brady).

Sagenella frondescens H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 41, pl. 5, fig. 1.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 195, pl. 5, fig. 16.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 278, pl. 28, figs. 14, 15.

Sagenina frondescens Chapman, Journ. Linn. Soc., vol. 28, 1900, p. 4, pl. 1, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 221, fig. 46 (in text).

Description.—Test attached, tubular, stout, the tubes forming an irregular network over the surface to which they are attached, dichotomously branching or irregular and often anastomosing to form a reticulated network; wall of fine sand with a small proportion of cement, rather thin; apertures at the ends of the tubes, rounded; color white, gray, or brown.

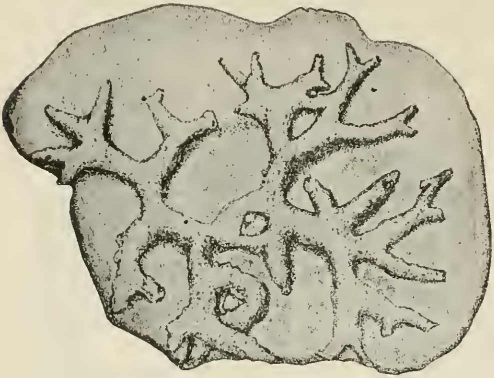


FIG. 93.—SAGENINA FRONDESCENS. × 10 (AFTER BRADY).

Diameter of the main tubes up to 0.5 mm., of the smaller ones as small as 0.12 mm.

Distribution.—Brady described this species from shallow water about the Admiralty and Friendly islands. A single fragmentary specimen was obtained from *Albatross* station D 4922 in Vincennes Strait, south of Japan, in 60 fathoms. At this and adjacent stations many other species of tropical Foraminifera seem to reach their northern limit.

SAGENINA RAMULOSA, new species.

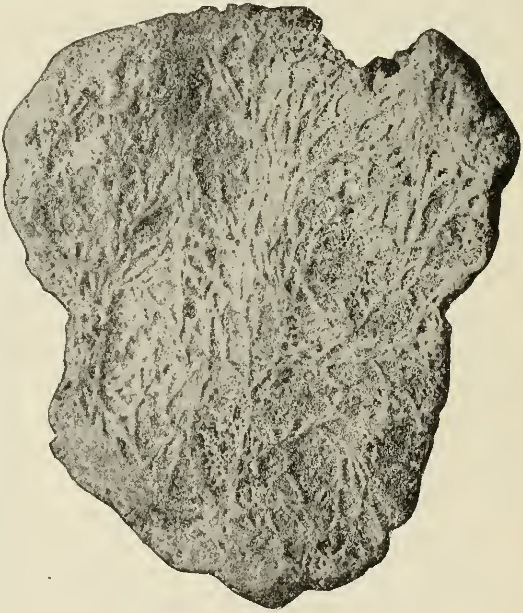


FIG. 94.—SAGENINA RAMULOSA. × 15. FROM PHOTOGRAPH.

Description.—Test attached, tubular, branching profusely at a small angle, tubes often massed or confluent; wall composed of fine coralline mud, smooth; apertures at the ends of the tubes; color, white.

Diameter of the tubes, 0.1–0.2 mm.

Type-specimen.—Cat. No. 8232, U.S.N.M., from *Nero* station 1066, off Guam, 234 fathoms in coral mud, attached to fragments of worn shell.

This species is very slender, much more profusely branching than any specimens of the preceding species that I have seen, and most of the branching at a very acute angle.

Subfamily 4. AMMODISCINÆ.

Test composed of a globular proloculum and long undivided tube, closely coiled, either planospirally or in changing planes or to form a spiral test; wall of fine sand with much cement.

Ammodiscus and its allies *Gordiammina*, *Ammodiscoides*, and *Turritellella* form a rather unified group in that they are all close coiled and are of fine material, with an abundance of reddish cement. As far as known the tests are all free. In *Ammodiscus* the two forms, microspheric and megalospheric, are known to occur.

Genus AMMODISCUS Reuss, 1861.

Operculina (part) D'ORBIGNY, Foram. Cuba, 1839, p. 71.

Orbis STRICKLAND, Quart. Journ. Geol. Soc., vol. 2, 1846, p. 30 (not *Orbis* of PHILIPPI, 1844=*Cornuspira*).

Spirillina WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 93 (not *Spirillina* EHRENBERG, 1841).

Trochammina (part) JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141.

Ammodiscus (part) REUSS, Sitz. kais. Akad. Wiss. Wien, vol. 44 (1), 1861 (1862), p. 365.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 189.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 329.—RHUMBLER, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 614.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 280. (Type, *A. incertus* D'ORBIGNY =*Operculina incerta* D'ORBIGNY).

Cornuspira (part) REUSS, and various authors (not *Cornuspira* SCHULTZE, 1854).

Involutina (part) TERQUEM, Mém. Acad. Imp. Metz, 1860-61 (1862), p. 450; 1862-63 (1863), p. 221.

Description.—Test free, spiral, composed of a proloculum and long undivided tubular second chamber, coiled regularly in one plane, wall finely arenaceous, cement usually brown, surface smooth.

I have restricted *Ammodiscus* to the basis of Rhumbler, including only those species which have a truly planospiral test.

AMMODISCUS INCERTUS (d'Orbigny).

Operculina incerta D'ORBIGNY, in De la Sagra, Hist. Phis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 49, pl. 6, figs. 16, 17; Spanish Edit., 1840, p. 71, pl. 6, figs. 16, 17.

Spirillina arenacea WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 93, pl. 7, fig. 203.

Trochammina squamata, var. *incerta* JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—PARKER and JONES, Appendix to W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 312.

Trochammina incerta W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 2.—HAEUSLER, Ann. Mag. Nat. Hist., ser. 5, vol. 10, 1882, p. 52, pl. 3.

Ammodiscus incertus H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 330, pl. 38, figs. 1-3.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 484, pl. 11, fig. 7.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 552, pl. 8, fig. 8.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 326, pl. 6, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 263, pl. 5, figs. 35, 36.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 31, pl. 6, figs. 238, 239.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 17.—Ann. Mag. Nat. Hist., ser. 6, vol. 16, 1895, p. 315, pl. 11, figs. 8, 9.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 34.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 278, pl. 23, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 362.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 614, fig. 32 (in text).—RHUMBLER, Zeitschr. allg. Phys., vol. 2, 1902, p. 1, fig. 18; Arch. Protistk., vol. 3, 1903, p. 280, fig. 129 (in text).—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 5.

Ammodiscus tenuis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 332, pl. 38, figs. 4–6.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 31, pl. 6, figs. 240, 241. —CHAPMAN, Proc. Zool. Soc. London, 1895, p. 18.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 23, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 281, fig. 130 (in text).

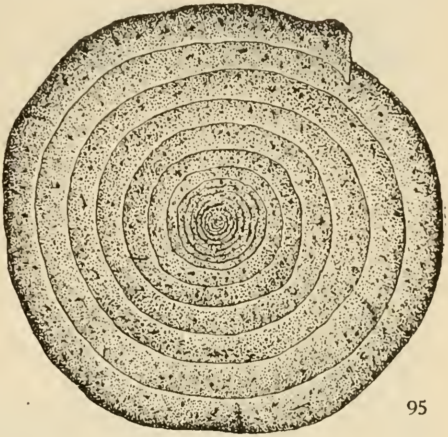
Description.—Test composed of an ovoid proloculum and long spirally coiled, undivided second chamber, coils in a single plane, gradually increasing in size, in the microspheric form very small in the center, in the megalospheric form much larger in the central portion and increasing but little in succeeding coils, in the adult condition chamber about as wide as high, building no floor of its own, aperture at the open end of the chamber, wall arenaceous, usually with an excess of cement, color usually a reddish or reddish-brown, in alcoholic specimens and sometimes in dry ones with the portion about the aperture white.

Diameter of test up to 6 mm.

Distribution.—Brady records a single station for this species in the North Pacific. Besides this station the volume on the "Summary of Results" of "The *Challenger* Report" adds another, 237, in 1,875 fathoms off Japan. Goës records the species as common off the west coast of Mexico and Central America from six *Albatross* stations. It is common in this material and from Station D3431, from which there are 129 specimens selected by Goës. Flint records it from Panama Bay in 51 fathoms.

Besides these records I have found the species in material from thirteen *Albatross* and *Nero* stations in the North Pacific. These are along the west coast of Mexico and the United States, at the entrance to the Gulf of California, off San Diego and off Oregon; two stations near the Hawaiian Islands; from along the south coast of Honshu Island, Japan, and near Guam. This gives a rather general distribution, but one station being north of lat. 40° N. The depths range from 20 to 3,125 fathoms, but only four stations are over 1,500 fathoms in depth. Of the shallower stations, two are 20 and 51 fathoms, the others between 250 and 1,150 fathoms, with the average of all less than 1,000 fathoms for this area.

There seems to be no great doubt that *Ammodiscus tenuis* H. B. Brady is the megalospheric form of the species of which *A. incertus* (d'Orbigny) is the microspheric form. From one station, *Albatross* D3431, there were 129 specimens, 26 of which were microspheric (*A. incertus*) and 103 megalospheric (*A. tenuis*); at station D3738, of 16 specimens, 2 were microspheric. At station D4337, 19 out of 30 specimens were microspheric. At several other stations both forms were obtained, but the amount of material did not admit of a large series being selected. In general, the megalospheric form is the more common, the usual feature wherever series of the two forms have been studied in other genera. Also the microspheric form is usually much larger than the megalospheric when the entire growth is finished. This also seems to be the general rule in the other Foraminifera observed from this standpoint.



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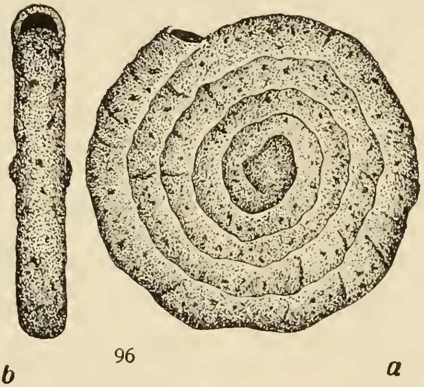

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Figs. 95–96.—Ammodiscus incertus. × 20. 95, large form with microspheric proloculum and many small early coils. 96 *a*, form with megalospheric proloculum, made up of a few large coils, the A. tenuis H. B. Brady which is the megalospheric form of A. incertus (d'Orbigny); *b*, apertural view of same specimen showing the megalospheric proloculum of greater diameter than the succeeding portions of the test.

AMMODISCUS EXSERTUS,
new species.

Description.—Test consisting of a proloculum and long undivided tubular chamber closely coiled for several revolutions, then uncoiling, but in the same plane, by a straight tube, wall finely arenaceous, with a reddish-brown cement, aperture at the end of the uncoiled portion, a circular opening slightly constricted.

Diameter 0.45 mm.

Type-specimen.—Cat. No. 8260, U.S.N.M., from *Albatross* D4979, in 943 fathoms, off the south coast of Honshu Island, Japan.

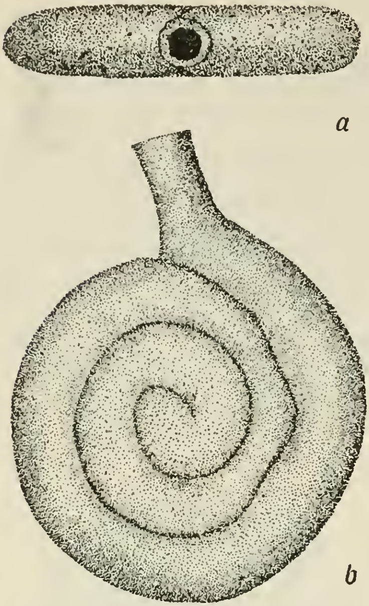

Fig. 97.—Ammodiscus exsertus. × 100. *a*, apertural view; *b*, front view.

The specimen figured by Brady[a] has a similar form, but less developed.

Genus GORDIAMMINA Rhumbler, 1895.

Trochammina (part) Jones and Parker, Quart. Journ. Geol. Soc., vol. 61, 1860, p. 304.

Ammodiscus (part) Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 5; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 333.

Gordiammina Rhumbler, Nachr. kön. Ges. wiss. Göttingen, 1895, p. 84; Arch. Protistk., vol. 3, 1903, p. 281. Type, *G. charoides* (Jones and Parker) = *Trochammina charoides* Jones and Parker.

Description.—Test composed of a proloculum and long, undivided second chamber, winding upon itself in various planes, not completely spiral throughout, wall finely arenaceous, with much cement, smooth both without and within, color reddish or yellowish brown.

Rhumbler has proposed a new generic name to include the two species which have the coiled chamber winding in varying planes but not in a regular spire. The method of growth is certainly very different from the planospiral one of *Ammodiscus*, and the generic name used by Rhumbler has been adopted here.

GORDIAMMINA GORDIALIS (Jones and Parker).

Trochammina squamata, var. *gordialis* Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—Parker and Jones, Trans. Roy. Soc. London, vol. 155, 1865, p. 408, pl. 15, fig. 32.

Trochammina gordialis W. B. Carpenter, Parker, and Jones, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 4.—Jones, Parker, and Kirkby, Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 390, pl. 13, figs 7, 8.—Wright, Proc. Belfast Field Club, 1876–77 (App.), pl. 4, fig. 3.—Haeusler, Ann. Mag. Nat Hist., ser. 5, vol. 10, 1882, p. 55, pls. 3 and 4, figs. 8–20.

Trochammina (*Ammodiscus*) *gordialis* Haeusler, Neues Jahrb., 1883, p. 59, pl. 4, figs. 2, 3.

Ammodiscus gordialis Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 5.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 196, pl. 5, fig. 22.—H. B. Brady, Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 100; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 333, pl. 38, figs. 7–9.—Haeusler, Neues Jahrb., Beil., vol. 4, 1885, p. 24, pl. 3, figs.

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[a] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 38, fig. 4.

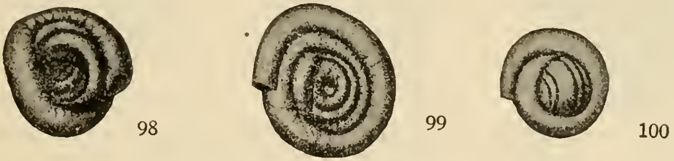
10–22, 31.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 218, pl. 42, fig. 22.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 469.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 264, pl. 5, figs. 39, 40.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 24., fig. 1.

Gordiammina gordialis Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84; Arch. Protistk., vol. 3, 1903, p. 282, fig. 132 (in text).

Description.—Test composed of a proloculum and long, undivided second chamber, at first planospiral like *Ammodiscus*, but soon leaving the one plane and becoming irregularly; coiled wall finely arenaceous with much cement; color reddish or yellowish brown.

Diameter 0.25–0.84 mm.

Distribution.—There are seven *Challenger* records for this species in the North Pacific, six of them in the abyssal region from Japan westward to the mid-Pacific and thence southward to the equator, the other one between Hongkong and Manila. These stations range in depth from 1,875 to 3,125 fathoms, mostly in red clay areas. The only other North Pacific record is that of Flint, *Albatross* station D3080, in 93 fathoms off the coast of Oregon.



Figs. 98–100.—Gordiammina gordialis. × 70 (after Brady).

Many of the figured fossil specimens are very peculiar, and a question may be raised as to whether they all belong to this species.

GORDIAMMINA CHAROIDES (Jones and Parker).

Trochammina squamata, var. *charoides* Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.

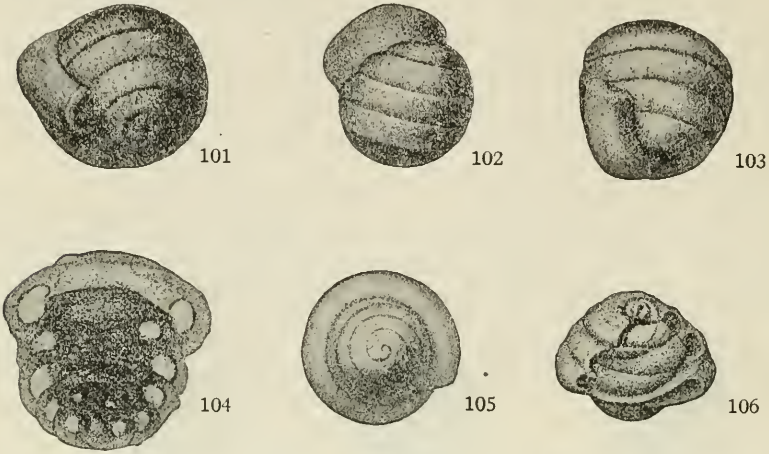
Trochammina charoides W. B. Carpenter, Jones, and Parker, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 3.—Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 5.—Haeusler, Ann. Mag. Nat. Hist., ser. 5, vol. 10, 1882, p. 56, pl. 4, fig. 21.

Ammodiscus charoides Berthelin, Foram. de Bourgneuf et Pornichet, 1878, p. 23, no. 18.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 334, pl. 38, figs. 10–16.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 469.—Chapman, Proc. Zool. Soc. London, 1895, p. 18.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 24, fig. 2.

Gordiammina charoides Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.—Kiær, Norske Nordhavs-Exp., no. 25, 1899, p. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 282, fig. 133 (in text).

Description.—Test consisting of a proloculum and long, undivided second chamber evenly coiled in a series of layers making a subglobular mass, then turning at right angles to its preceding axis and making finally a partial or complete revolution about the earlier-formed globular test; wall finely arenaceous with much cement; surface smooth and polished; color reddish brown.

Diameter 0.34–0.4 mm.



Figs. 101-106.—Gordiammina charoides. × 70 (after Brady). 104, section through test. 105, apertural view. 106, broken specimen showing coils of interior.

Distribution.—This species is known in the North Pacific from two *Challenger* stations in 1,875–2,575 fathoms, east from Japan. Brady also mentions a North Pacific station "from 50–150 fathoms." Flint records the species from off the coast of Oregon, 93 fathoms, from *Albatross* station D3080.

Genus TURRITELLELLA Rhumbler, 1903.

Trochammina (part) Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 46.

Ammodiscus (part) Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 5.—Balkwill and Millett, Journ. Micr. and Nat. Sci., vol. 3, 1884, p. 25.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 335.

Turritellopsis Rhumbler (not of G. O. Sars, 1878), Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.

Turritellella Rhumbler, Arch. Protistk., vol. 3, 1903, p. 283.

Description.—Test free, consisting of a proloculum and long, undivided second chamber, coiled in an elongated close spiral, wall composed of sand grains and much cement, smooth; aperture, the open end of the tubular chamber.

The single species here included has a long, closely spiral test very different from any of the preceding, and it seems proper that it should have a different generic name.

TURRITELLELLA SHONEANA (Siddall).

Trochammina shoneana SIDDALL, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 46, figs. 1, 2.

Ammodiscus shoneanus SIDDALL and H. B. BRADY, Cat. Brit. Rec. Foram., 1879, p. 5.—BALKWILL and WRIGHT, Proc. Roy. Irish Acad., vol. 3, 1882, p. 546; Journ. Micr. and Nat. Sci., vol. 3, 1884, p. 25, pl. 1, fig. 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 335, pl. 38, figs. 17–19.

Turritellopsis shoneanus RHUMBLER, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84; Zeitschr. allg. Phys., vol. 2, 1902, p. 284, fig. 103.

Turritellella shoneana RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 283, text fig. 135.

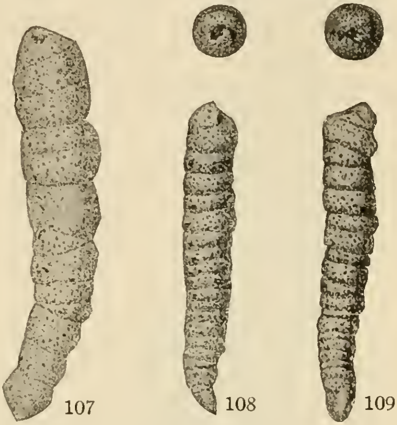
Description.—Test free, composed of a proloculum and long undivided tubular second chamber, in a close coiled, elongate spiral, of nearly uniform diameter, wall finely arenaceous, with much cement, rounded open end of the tubular chamber serving as the aperture, color reddish-brown.

Length 0.25–0.5 mm.

Distribution.—The only North Pacific record for this species is the deepest of the *Challenger* dredgings, station 238, 3,950 fathoms, east of Japan. In other parts of the world this species has been found in rather shallow water.

Family 3. LITUOLIDÆ.

Test composed of agglutinated material for the most part; consisting of two or more chambers; arranged in a linear, coiled or irregular series; apertures usually one to each chamber, but sometimes more.



FIGS. 107-109.—TURRITELLELLA SHONEANA. × 100 (AFTER BRADY).

The tests included in this family all have the wall composed of agglutinated material with a varying amount of cement in the various genera. Throughout the family as here used the tests are composed of two or more chambers and a definite proloculum is apparent. Usually the tests are composed of a series of chambers. There are well marked genera in the coiled group which in their later growth show a decided uncoiling and this may be carried to an extreme in such forms as *Ammobaculites agglutinans* where only the early portion shows any trace of coiling.

Several new genera have been made to include species which are very different in their plan of growth. The genera *Haplophragmium* and *Trochammina* especially have been divided. According to the type-species of *Haplophragmium* the test is uncoiled in later development, closely coiled when young, more or less labyrinthic in the interior and having several apertures. Such forms occur most commonly among the fossil series, but are also known as recent species in the East Indies. Therefore the genus *Haplophragmium* is here restricted to those species none of which have been recorded from the North Pacific.

The planospiral forms are here separated from the trochoid ones, as in the Mollusca, for example, these two types are always distinct, and it has seemed best to keep them so even in the Foraminifera. The uncoiling and closely coiled planospiral forms have also been separated. A number of previously proposed names have been used. Certain of the genera include species not hitherto described in this group, and which are apparently new.

After a careful review of the work done by various authors the scheme of distributing the genera of the Lituolidæ among the various families with which they are supposed to have affinities, has been avoided. It is less confusing, it seems to me, to keep the family as it now is, especially when the relationships of the arenaceous and calcareous forms are so hazy and uncertain and in other cases when details of structure are carefully considered the apparent likeness is lost. It has seemed best, therefore, to regard the similarity of form as cases of parallelism and not true relationships.

Subfamily 1. ASCHEMONELLINÆ.

Test composed of agglutinated material, divided irregularly into chambers without definite plan of arrangement.

The two species of *Aschemonella* recorded from this area are primitive in character. The chamber seems to produce orifices at irregular positions and from any of these a new series of chambers may be initiated, thus giving rise to an irregularly formed test. In this respect these species seem more primitive than the rest of the family and are here separated from them.

Genus ASCHEMONELLA H. B. Brady, 1879.

Astrorhiza (part) Norman, Proc. Roy. Soc. London, vol. 25, 1876, p. 213.

Aschemonella H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 42.—Bütschli, in Bronns Klassen, und Ordnungen des Thierreichs, vol. 1, 1880, p. 195. Type, *Aschemonella catenata* (Norman)=*Astrorhiza catenata* Norman.

Description.—Test free, composed of a number of tubular or inflated chambers in a single or branching series, irregular in form and size, walls arenaceous, firm, thin, apertures often several, at the end of tubular necks.

The two following species were recorded from the material of the *Challenger* expedition as occurring in the North Pacific.

ASCHEMONELLA RAMULIFORMIS H. B. Brady.

Aschemonella ramuliformis H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 273, pl. 27, figs. 12–15.

Description.—"Test free, elongate; forming an irregular, more or less branched, sometimes segmented tube, with numerous apertures, lateral and terminal. Walls very thin, but hard and firmly cemented; exterior only slightly rugose, interior surface smooth. Length, $\frac{1}{3}$ inch (8 mm.)."

Distribution.—Found at three *Challenger* stations in the North Pacific, 244, 246, and 253, in 2,050–3,125 fathoms. Most common at station 244 in 2,900 fathoms.

ASCHEMONELLA CATENATA (Norman.)

Astrorhiza catenata Norman, Proc. Roy. Soc. London, vol. 25, 1876, p. 213.

Aschemonella catenata H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 42, pl. 4, figs. 12, 13; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 271, pl. 27, figs. 1–11; pl. 27 A, figs. 1–3.

Aschemonella scabra H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 44, pl. 3, figs. 6, 7.

Description.—"Test free, irregularly branched; chambers numerous, inflated, variable in size and contour, usually with several tubulated orifices, each of which may produce a fresh segment. Walls thin, compactly built, exterior more or less rough, often acerose with partially embedded sponge-spicules; interior smooth. Complete specimens sometimes $\frac{5}{12}$ inch (10.5 mm.) in length."

Distribution.—This species is recorded at four *Challenger* stations in the North Pacific, 224, 237, 244, 246, in 1,850–2,900 fathoms. Brady speaks of the specimens from station 244 as the finest obtained by the *Challenger*.

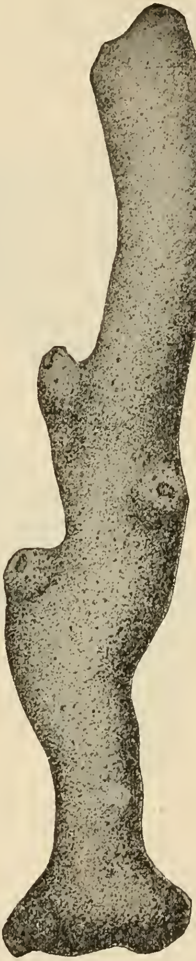
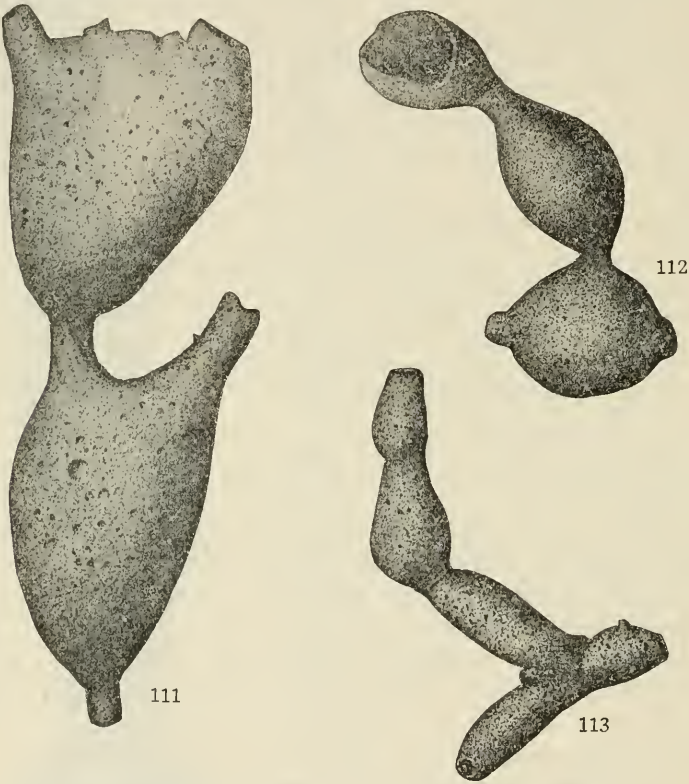


Fig. 110.—Aschemonella ramuliformis. × 15. (After Brady.)

Subfamily 2. REOPHACINÆ.

Test of agglutinated material, sand grains, sponge-spicules, etc., with a varying amount of cement, chambers in a linear series, aperture single at the end of the last formed chamber.

This subfamily includes many species mainly belonging to *Reophax* and *Hormosina.* The chambers vary in relative length and in their relative position, sometimes closely fitting one over the other, sometimes drawn out with long tubular portions between the chambers. There is much difference in the materials used by various species, sand grains being the usual material, but certain species select sponge-spicules and in one species, *Reophax membranaceus* the test is composed largely of chitinous material.



Figs. 111–113.—Aschemonella catenata. × 15 (after Brady).

Genus REOPHAX Montfort, 1808.

Reophax Montfort (type, *R. scorpiurus* Montfort), Conch. Syst., vol. 1, 1808, p. 330, 83^{me} genre.—H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289.—Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 675.

Nodosaria d'Orbigny (not of Lamarck, 1812) (part), Ann. Sci. Nat., vol. 7, 1826, p. 255.—Terquem, Mém. Acad. Imp. Metz, vol. 51, 1870, p. 354.

Lituola Parker and Jones (part), Trans. Roy. Soc. London, vol. 155, 1865, p. 407.—Parker, Can. Nat., vol. 5, 1870, pp. 177, 180.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 159.—Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 47.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 192.

Haplostiche Schwager (not of Reuss, 1861), Jahresh. Ver. vat. Naturk. Württemburg, vol. 21, 1865, p. 92.

Nodulina Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 85.

Description.—Test free, composed of a linear series of chambers, joined end to end in a nearly straight line, sometimes slightly curved or irregular but not coiled, wall coarsely arenaceous, chambers undivided, aperture simple and terminal.

This genus as now modified includes the multiple chambered uniserial arenaceous forms with undivided chambers and a single oral aperture.

REOPHAX SCORPIURUS Montfort.

"*Orthoceras*" ?, SOLDANI, Testaceographica, vol. 1, 1795, p. 239, pl. 162, fig. K.

Reophax scorpiurus MONTFORT, Conch. Syst., vol. 1, 1808, p. 330, 83^{me} genre.—W. B. CARPENTER, The Microscope, 6th ed., 1881, p. 564, fig. 321*c*.—H. B. BRADY, Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 99.—HAEUSLER, Quart. Journ. Geol. Soc., vol. 39, 1883, p. 27, pl. 2, fig. 7.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 291, pl. 30, figs. 12–17.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 328, pl. 13, figs. 5 *a*, *b*.—HAEUSLER, Neues Jahrb. für Min., Beil., vol. 4, 1885, p. 9, pl. 1, figs. 9–16.—A. AGASSIZ, Bull. Mus. Comp. Zoöl., vol. 15, 1888, p. 163, fig. 495 (in text).—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 217, pl. 41, fig. 10.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 27, pl. 5, figs. 23, 24.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 467.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 320, pl. 5, figs. 4, 5.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 257, pl. 4, fig. 18; pl. 5, figs. 45, 46.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 24, pl. 5, figs. 158–163; pl. 6, figs. 164–167 [not 168–171].—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 14.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 26.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 273, pl. 16, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 254.—GUPPY, Proc. Victoria Inst., Trinidad, vol. 2, 1902, p. 3, pl. 2, fig. 2.—CHAPMAN, Trans. and Proc. New Zealand Inst., vol. 38, 1906, p. 84.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

Nodosaria (*Dentalina*) *scorpionus* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 255, No. 40.

Lituola scorpiurus H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 467, pl. 48, fig. 5.—Nat. Hist. Trans. Northumberland, vol. 1, 1867, p. 96, pl. 12, fig. 3.—DAWSON, Can. Nat., vol. 5, 1870, p. 177, fig. 4.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 159, pl. 9, fig. 29.—DAWSON, Amer. Jour. Sci., vol. 1, 1871, p. 206, fig. 4; Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86, fig. 4.

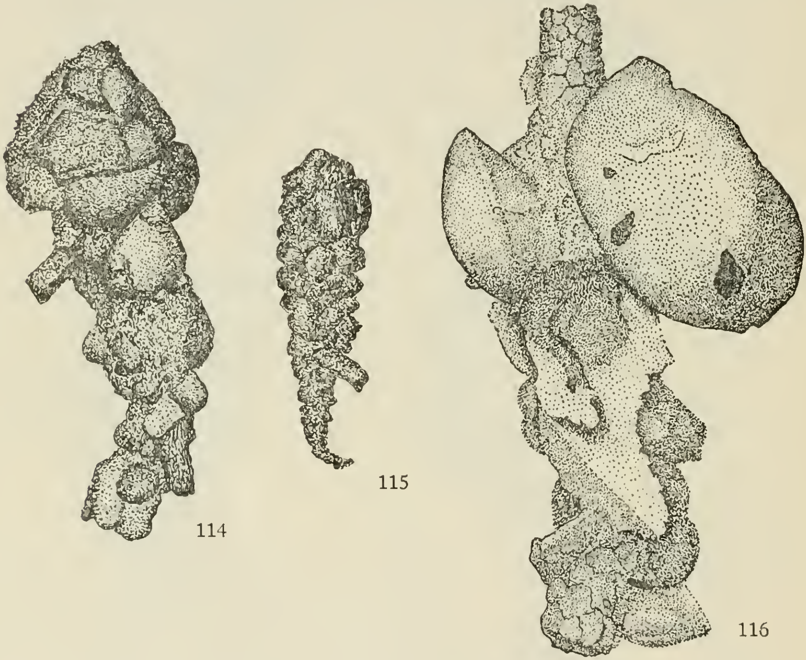
Lituola nautiloidea, var. *scorpiurus* PARKER and JONES, Trans. Roy. Soc. London, 1865, p. 407, pl. 15, fig. 48 *a*, *b*.—H. B. BRADY, Pal. Soc. Monogr., vol. 30, 1876, p. 63, pl. 8, fig. 7.—SCHWAGER, Boll. Reg. Com. Geol. Ital., vol. 8, 1877, p. 26, fig. 87.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 192, pl. 5, fig. 18.

Description.—Test consisting of a number of chambers, rapidly increasing in size as added, early chambers irregularly arcuate, later ones more nearly straight, surface rough, of fairly large sand grains, aperture simple, with a short neck, small.

Length 0.5–2 mm.

Distribution.—This species is recorded by Brady at seven *Challenger* stations from 40 fathoms on the coral reefs of Honolulu to 3,950 fathoms in the abyssal region east of Japan. Goës records it from *Albatross* station D3431, 995 fathoms at the entrance to the Gulf of California as scarce. Bagg records it from three stations near the Hawaiian Islands, 495–1,307 fathoms. I have found it in North Pacific material, from about Japan at a number of stations, and from the vicinity of Hawaii, usually in rather shallow water in both regions.

Of Bagg's specimens, only one, that from station D4567, can belong to this species. Of the other two specimens, one is not *Reophax*, the other very questionable. Some of the Goës material is typical, some of it rather nondescript.



Figs. 114–116.—Reophax scorpiurus, 114, specimen from Hawaiian Islands, 114 fathoms. × 20. 115, specimen from off Japan, 77 fathoms. × 15. 116, specimen of questionable character from Hawaiian Islands, 217 fathoms. × 10.

A review of the above synonymy will show that this specific name has been a sort of dumping ground for every irregular arenaceous Foraminifer or worm tube which is not definitely coiled or not well characterized. The original figure of Soldani on which Montfort based this species shows an arenaceous test with the early chambers irregularly arcuate, the later ones nearly straight and larger. Montfort made a fanciful copy of this figure of Soldani and the result is rather surprising, the figured specimens being made to show a network of raised ribs which were the lines between the sand grains in

Soldani's figure. With such a copy and the subsequent figures showing all sorts of arenaceous tests it is no wonder that there has existed great confusion in regard to this species.

The species is here restricted to those specimens showing the typical structure, such as Goës, 1894, pl. 5, fig. 158; pl. 6, figs. 164, 166, 167, and Flint, 1899, pl. 16, fig. 3.

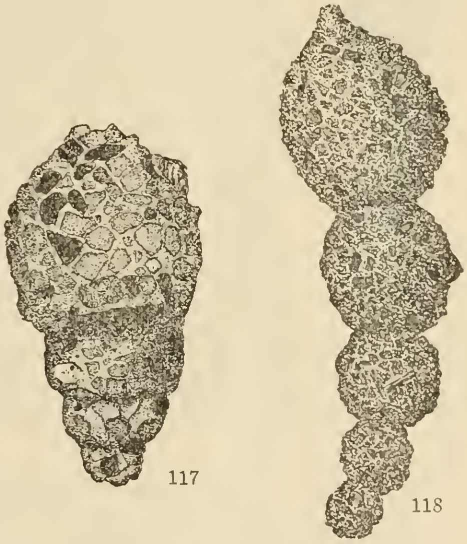
REOPHAX PILULIFER H. B. Brady.

Reophax pilulifera H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 292, pl. 30, figs. 18–20.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, pt. 7, 1888, p. 217, pl. 41, figs. 5–7 [8?].—Chapman, Proc. Zool. Soc. London, 1895, p. 15.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 273, pl. 18, fig. 1.

Description.—Test composed of few (three to five) chambers, arranged in a straight or slightly arcuate line, chambers subglobose, each much larger than the preceding, walls of coarse sand grains, but rather neatly cemented with considerable cement, giving a fairly smooth exterior, aperture small, often with a slight neck-like protuberance.

Length up to 2.5 mm.

Distribution.—In the *Challenger* material from the North Pacific this species occurs at stations 237 and 244, 1,875 and 2,900 fathoms, east of Japan. Goës found it in the *Albatross* material at station D3419, in 772 fathoms, in the eastern tropical Pacific, not 1,800 fathoms as he recorded it. His selected material consists of ten specimens from this station, a typical one of which is here figured. I have found two specimens from *Albatross* station D4957, in 437 fathoms, south of Japan. The figures given by Goës in 1894 are really *R. guttifer* H. B. Brady. Fig. 8, at least, of Brady, Parker, and Jones, 1888, is very questionable.



Figs. 117–118.—Reophax pilulifer. 117, specimen from series selected by Goës. × 20. 118, another specimen. × 35.

REOPHAX DISTANS H. B. Brady.

Reophax distans H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 296, pl. 31, figs. 18–22.—Chapman, Proc. Zool. Soc. London, 1895, p. 15.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.

Description.—Test composed of a few fusiform chambers with long slender connections in a straight line or irregular, usually not more than three chambers found together, wall of coarse sand grains, but rather smoothly cemented, thin.

Length of three chambered specimens, 5 mm.

Distribution.—The *Challenger* obtained this species from four North Pacific stations, 1,875–2,050 fathoms, between Japan and 180°. Goës records it from three *Albatross* stations off the west coast of Mexico and Central America, station D3419, 772 fathoms; D 3399, 1,740 fathoms; D3375, 1,201 fathoms. I have found single chambers in material from the stomachs of Holothurians taken at *Albatross* station D3603 in 1,771 fathoms, in Bering Sea; also single chambers at *Nero* station 1012, in 1,932 fathoms, north of Guam. The figured specimen is from *Albatross* station D3375.

Goës speaks of this material as "more globiform" than the specimens figured by Brady, but the material of Goës that I have examined seems very typical, consisting of ten single chambers and the one three-chambered specimen figured here. The slender connections between the chambers are very easily broken, and complete specimens are very rare.

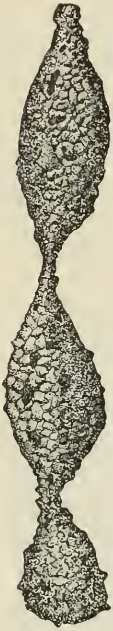


FIG. 119.—REOPHAX DISTANS. ×40.

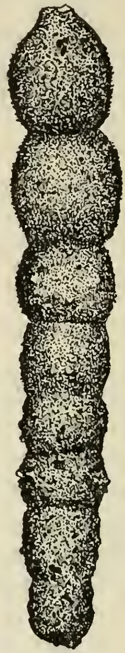


FIG. 120.—REOPHAX BACILLARIS. ×15.

REOPHAX BACILLARIS H. B. Brady.

Reophax bacillaris H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 49; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 293, pl. 30, figs. 23, 24.—DE AMICIS, Nat. Sic., vol. 14, 1895, p. 72, pl. 1, fig. 17.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 254, pl. 14, fig. 12.

Description.—Test elongate, regularly tapering, usually with an angle near the basal portion, composed of a large number (sometimes as many as thirty) of short chambers, earlier ones often less distinct than the later ones, aperture small, usually at the end of a very short neck-like protuberance; color gray.

Length up to 5 mm.

Distribution.—The only published records for the North Pacific are two stations from the eastern tropical Pacific recorded by Goës, *Albatross* stations D3375, D3376, 1,132 and 1,201 fathoms. I have examined his material from the latter station, two specimens, each with eight chambers, evidently not complete, but of the typical form. One of these specimens is figured (fig. 120).

REOPHAX DENTALINIFORMIS H. B. Brady.

Reophax dentaliniformis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 49; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 293, pl. 30, figs. 21, 22.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 25, pl. 6, figs. 172–175.—SCHLUMBERGER, Mém. Soc. Zool. France, vol. 7, 1894, p. 239.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 254.

Reophax nodulosa BAGG (not H. B. BRADY), Proc. U. S. Nat. Mus., vol. 34, 1908, p. 23.

Description.—Test slender, tapering, composed of a few (five or six) elongated chambers, but slightly tumid in the middle, in a straight or slightly curved line, walls composed of rather coarse sand grains but very neatly cemented together, giving a fairly smooth exterior, aperture rather large, at the end of the short tubular neck; color gray.

Length up to 2 mm.

Distribution.—This species is now known from fifteen stations in the North Pacific, down to 3,950 fathoms off Japan. Schlumberger records the species from the Okhotsk Sea and the other stations cover rather well the area south of lat. 40° N. from the coast of Japan to the Hawaiian Islands and off the west coast of Mexico and Central America.

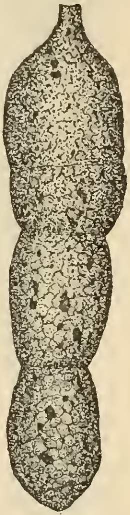


FIG. 121.—REOPHAX DENTALINIFORMIS. × 20.

Goës's specimens from Station D3276, 1,132 fathoms, are for the most part complete and typical. The specimen referred by Bagg to *Reophax nodulosus* is really a specimen of *R. dentaliniformis* H. B. Brady.

REOPHAX NODULOSUS H. B. Brady.

Reophax nodulosus H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 52, pl. 4, figs. 7, 8; Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 99; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 294, pl. 31, figs. 1–9.—TOUTKOWSKI, Zap. Kievsk. obshch. Est., vol. 9, 1888, p. 5, pl. 2, figs. 2 *a*, *b*.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 256, pl. 4, figs. 5–7, 12, 13 [?].—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 26, pl. 6, figs. 187–191.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 4.

Description.—Test elongate, tapering, usually straight but sometimes arcuate, consisting of several chambers (usually less than twelve) pyriform in shape, the proximal part of each chamber broadest, thence tapering gently toward the distal end, chambers gradually increasing in size toward the distal end of the test, exterior, in the large form with short chambers, roughish, in the form with long chambers, smooth; aperture large, at the end of the tapering chamber; color usually grayish.

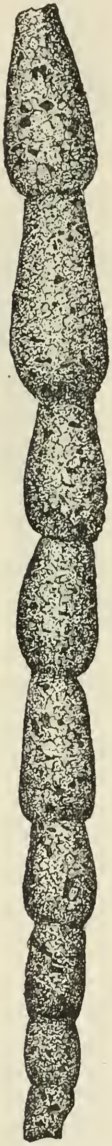


FIG. 122.—REOPHAX NODULOSUS. × 25.

Length very variable, up to 25 mm.

Distribution.—There are ten published records for this species which with the new stations from the *Albatross* and *Nero* soundings give a very general distribution for this species in the North Pacific, depths ranging from 941–3,950 fathoms.

Bagg's specimen from *Albatross* station H4585 assigned to this species is *Reophax dentaliniformis* H. B. Brady, as I find upon examination of his material. Goës's specimens, as well as all other North Pacific material that I have seen, are like plate 31, figs. 3 and 4 of the *Challenger* Report. Some of Goës's specimens had nine chambers. His specimens from the Caribbean Sea are more like figures 6–8 of the same plate, and it is very probable that Brady has included more than one species under this name. Egger's figures seem to represent a mixed assemblage of little character, none of which appears to be a typical *Reophax nodulosus.*

REOPHAX GUTTIFER H. B. Brady.

Reophax guttifera H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 49; Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 295, pl. 31, figs. 10–15.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 26, pl. 6, figs. 192–195.

Reophax pilulifer GOËS (not H. B. BRADY), Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 25, pl. 6, figs. 176–180.

Description.—Test elongate, nearly straight, composed of from 3–8 chambers, typically pyriform, broadest at the base and rather rapidly narrowing to the aperture at the distal end of the chamber, wall composed of coarse sand grains, rather roughly cemented; color yellowish-brown.

Length up to 1.6 mm.

Distribution.—With the exception of the Philippines the only records for the North Pacific for this species are from the *Challenger* material, stations 237 and 246, 1,875 and 2,050 fathoms, east of Japan.

The narrow stolon-like connections between the chambers make the test very fragile and probably account for the fact that specimens with slender connections are composed of few chambers. Goës's figures are very small and it is difficult to determine exactly what he had. Goës's figures of *R. pilulifer* are apparently *R. guttifer*, as near as one can make out.

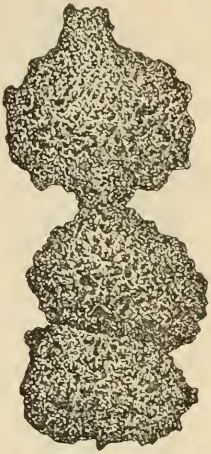


FIG. 123.—REOPHAX GUTTIFER. × 100.

REOPHAX INSECTUS Goës.

Reophax insectus GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 28, pl. 3, figs. 6, 7.

Description.—Test stout, tapering, consisting of several short, inflated chambers, each larger than the preceding one, wall composed of large sand grains and rather rough on the exterior; circular in end view; light gray in color.

Length 5–8 mm., the last chamber often 2 mm. in diameter.

Distribution.—Goës described this species from material from *Albatross* stations off the west coast of Mexico and near the Galapagos Islands, *Albatross* stations D3407, D3419, and D3431, in 772–995 fathoms. Besides seeing the original material and finding additional specimens at the last station, I have found two specimens from *Albatross* station D4337, in 617–680 fathoms off San Diego, California. The material from this station was very similar to that from farther south, and might equally well be termed "Rhabdammina ooze."

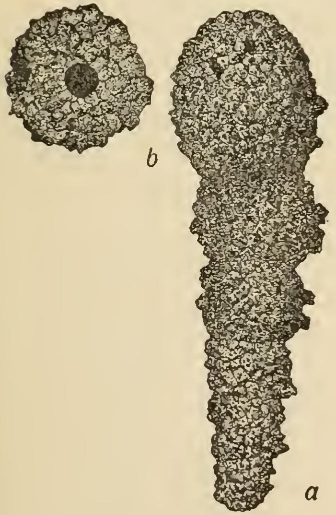


FIG. 124.—REOPHAX INSECTUS. × 12. *a*, SIDE VIEW; *b*, END VIEW.

REOPHAX ADUNCUS H. B. Brady.

Reophax adunca H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 296, pl. 31, figs. 23–26.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 5.

Description.—Test consisting of several subglobular chambers in an irregular line, constrictions between the chambers slight, walls thin, composed of rather coarse sand grains giving a rough exterior, length indefinite, 2 mm. or more.

Distribution.—The only North Pacific records for this species are from *Challenger* stations 237, 244, 246, and 256, 1,875–2,950 fathoms, all curiously enough between lat. 30° and 40° N.

This differs from the other species of *Reophax*, and when its early development is known, may be placed elsewhere. It has the appearance of the later chambers of certain attached species which later become free or coiled species, straightening out in their later development. Flint's figures show specimens of identical character with those obtained by the *Challenger*.

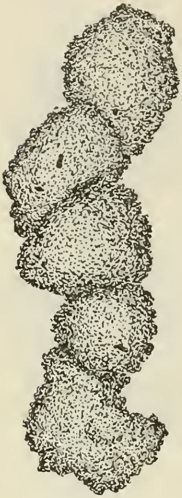


Fig. 125.—Reophax aduncus. × 50.

REOPHAX MEMBRANACEUS H. B. Brady.

Reophax membranacea H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 53, pl. 4, fig. 9; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 297, pl. 32, figs. 1–4.—Millett, Journ. Roy. Micr. Soc., 1899, p. 255, pl. 4, fig. 14.

Description.—Test elongate, slender, tapering, straight or slightly curved, consisting of from five to ten subcylindrical, elongated chambers, slightly tumid in the middle; walls thin, chitinous, of a brown color; length up to 1.4 mm.

Distribution.—Brady records this species from *Challenger* station 238 in 3,950 fathoms off Japan and in the volume on the "Summary of Results" it is questionably recorded from the next station, 237, in 1,875 fathoms. I have found specimens in material from three *Nero* stations, 1012, 1021, 1030, in 1,932–2,112 fathoms, north of Guam. Specimens were very rare.

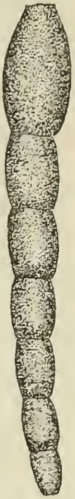


Fig. 126.—Reophax membranaceus. × 200.

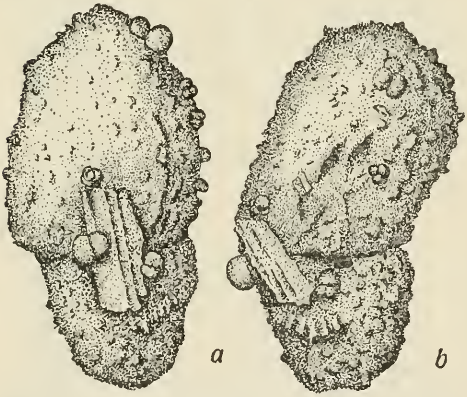


Fig. 127.—Reophax bilocularis. × 25, *a*, front view; *b*, side view showing the obliquity of the chambers.

These specimens, one of which is figured here, are more like the specimens figured by Brady than those figured by Millett. The walls are very thin and clean.

REOPHAX BILOCULARIS Flint.

Reophax bilocularis Flint, Rep. U.S. Nat. Mus., 1897 (1899), p. 273, pl. 17, fig. 2.

Description.—Test composed of two chambers in a straight line or set at an angle, chambers oval, walls of foreign matter, sand and largely of tests of other Foraminifera, surface irregular, aperture at the end of a tubular neck.

Length up to 2.5 mm.

Distribution.—I have found a single specimen from *Nero* station 1464, in 891 fathoms in globigerina ooze. This station is just north of Guam. The specimen appears to belong to this species. It has two chambers of an oval shape, set at a slight angle. The wall made up of a small part of sand with tests of other Foraminifera and other foreign material making up the rest.

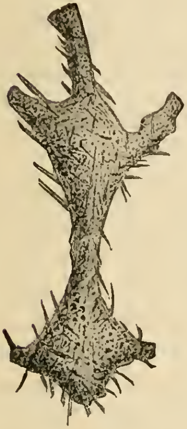
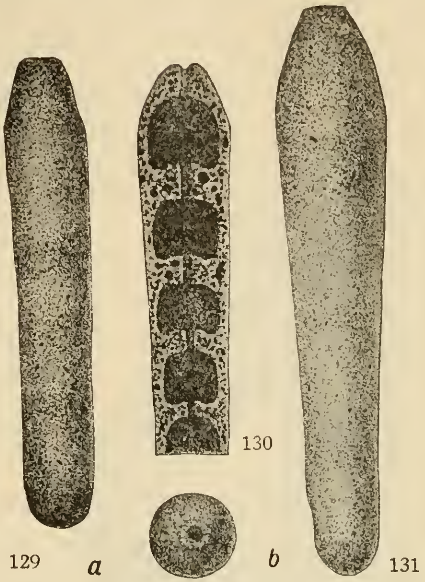


FIG. 128.—REOPHAX ARMATUS. × 22 (AFTER GOËS).



FIGS. 129–131.—REOPHAX CYLINDRICUS. × 20 (AFTER BRADY). 129 *a*, SIDE VIEW; *b*, APERTURAL VIEW. 130, LONGITUDINAL SECTION. 131, SIDE VIEW.

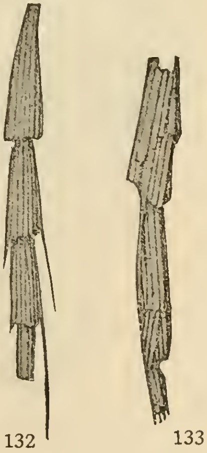
REOPHAX ARMATUS Goës.

Reophax armatus GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 29, pl. 1, fig. 1.

There are no specimens of this peculiar form in the material returned to the National Museum by Goës. From his figure and description it is difficult to determine just what was the character of Goës's specimens. The Pacific specimen was from *Albatross* station D3415 in 1,879 fathoms, off the coast of Mexico.

REOPHAX CYLINDRICUS H. B. Brady.

Reophax cylindrica H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 299, pl. 32, figs. 7–9.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 257, pl. 4, fig. 37 [?].—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 6.



FIGS. 132–133.—REOPHAX SPICULIFER. × 50 (AFTER BRADY).

This species is recorded in the volume of the *Challenger* report on the "Summary of Results," from station 237, 1,875 fathoms, east of Japan. The record is followed by a question mark, as though there were some doubt about the correctness of the determination.

REOPHAX SPICULIFER H. B. Brady.

Reophax spiculifera H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 54, pl. 4, figs. 10, 11; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 295, pl. 31, figs. 16, 17.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 258, pl. 4, fig. 19 (?).—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 14.

Description.—Test composed of a few chambers, broadest at the posterior end of each and gradually narrowing to the apertural end; wall composed of elongate sponge spicules arranged in general lengthwise of the chamber, often projecting back toward the posterior end of the chamber; aperture circular.

Length about 1 mm.

Distribution.—In the volume of the *Challenger* report on the "Summary of Results" this species is recorded with a question mark from stations 237 and 246, 1,875 and 2,050 fathoms. I have not met with it in the material I have examined from the North Pacific.

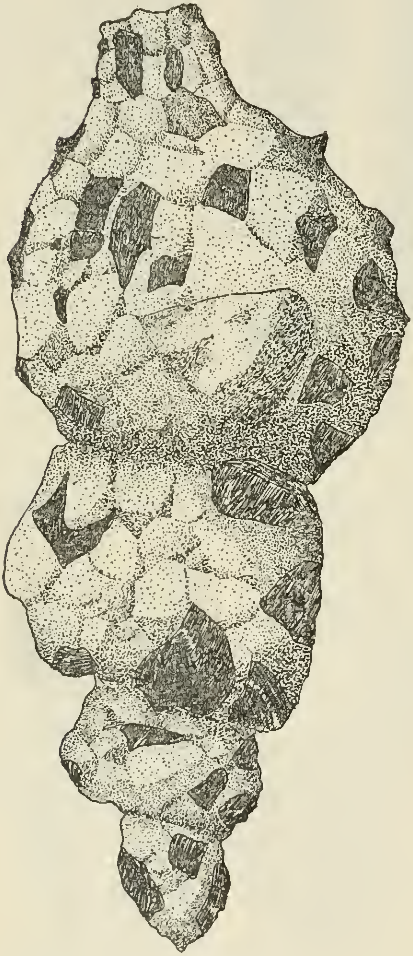


FIG. 134.—REOPHAX EXCENTRICUS. × 80.

REOPHAX EXCENTRICUS, new species.

Description.—Test small, composed of a nearly straight linear series of chambers, the size rapidly increasing with each newly added chamber; wall composed of sand grains, rather neatly cemented together; aperture at the end of a short tubular neck at one side of the axis of the test, varying somewhat in the amount of its eccentricity; color gray.

Length, 1.5 mm.; diameter of last-formed chamber often 0.6 mm.

Type-specimen.—Cat. No. 8261, U.S.N.M., from *Albatross* station D3603, from the stomachs of Holothurians dredged in 1,771 fathoms in Bering Sea.

REOPHAX CATENULATUS, new species.

Description.—Test consisting of a series of subglobular chambers of large size connected by rather slender tubular portions, walls of coarse sand grains very roughly cemented, color gray or yellowish-brown.

Length of three chambers, 7 mm.; diammeter of largest chamber, 1.8 mm.

Type-specimen.—Cat. No. 8262, U.S.N.M., from *Albatross* station D4965 in 191 fathoms, off the southern coast of Japan.

This is one of the largest species of the genus and the exterior is very rough.

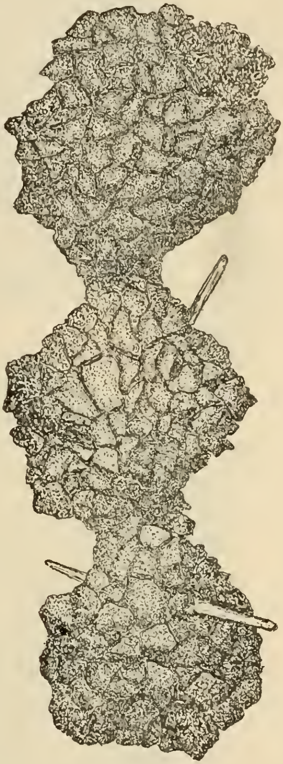


FIG. 135.—REOPHAX CATENULATUS. × 25.

Genus HORMOSINA H. B. Brady, 1879.

Hormosina H. B. BRADY (type, *H. globulifera* H. B. BRADY), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 56.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 199.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 325.

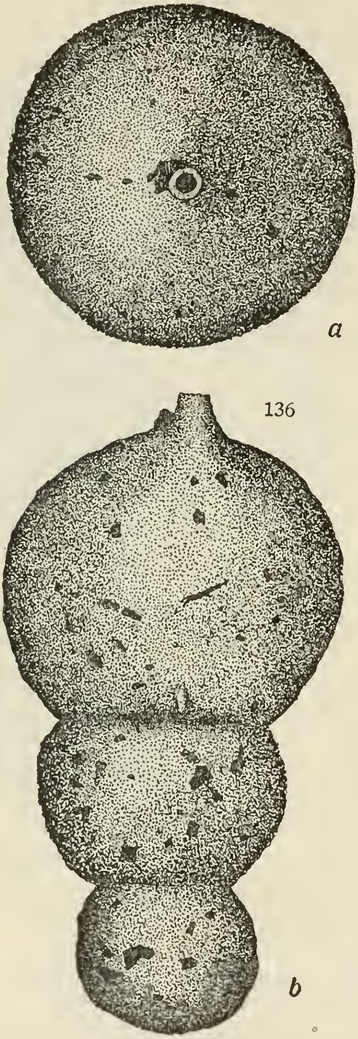
Description.—Test free, composed of a series of subglobular, fusiform or pyriform chambers joined end to end in a single moniliform series, walls thin, finely arenaceous, chambers undivided, aperture a single circular opening at the distal end of the neck of the chamber, color brownish.

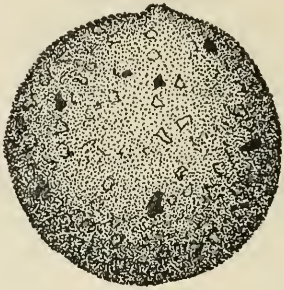
This genus differs from *Reophax* mainly in its fine texture, smooth surface, and brown cement. Several species occur in the North Pacific, but usually in fairly deep water.

HORMOSINA GLOBULIFERA H. B. Brady.

Hormosina globulifera H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 60, pl. 4, figs. 4, 5.—W. B. CARPENTER, The Microscope, 6th ed., 1881, p. 563, fig. 320c (in text).—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 326, pl. 39, figs. 1-6.—DE FOLIN, Le Naturaliste, vol. 10, 1888, p. 87, figs, 1, 2.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 29, pl. 6, figs. 218, 219.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 17.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 34.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 280, pl. 24, fig. 4.

Description.—Test composed typically of a few subglobular chambers, each larger than its predecessors and more or less embracing it, arranged in a straight or slightly arcuate line, aperture small, at the end of a definite, tubular neck, walls finely arenaceous, thin, surface smooth both within and without; color, light brownish.





Figs. 136–137.—Hormosina globulifera. 136*a*, end view showing aperture; *b*, front view, × 35. 137, single chambered form, × 40.

Length about 3 mm.

Distribution.—In the *Challenger* material this species occurred at four North Pacific stations, 237, 241, 244, 246, in 1,875–2,900 fathoms, all on the eastward voyage from Japan to the mid-Pacific. Goës records the species from four *Albatross* stations in the eastern tropical Pacific, D3375, D3376, D3407, D3415, in 888–1,879 fathoms. The figured specimen is from the Goës material from Station D3415.

Goës speaks of the specimens as not quite typical, but his specimens agree very well with Brady's figures and description.

HORMOSINA OVICULA H. B. Brady.

Hormosina ovicula H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 61, pl. 4, fig. 6.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 199, pl. 5, fig. 15.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 327, pl. 39, figs. 7–9.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 29, pl. 6, figs. 220, 221.—Chapman, Proc. Zoöl. Soc. London, 1895, p. 17.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 280, pl. 25, fig. 2.

Hormosina ovicula, var. Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 34, pl. 4, fig. 3.

Description.—Test composed of several fusiform chambers joined end to end with slender connective portions, in a straight or slightly curved line, wall thin, finely arenaceous, color yellowish-brown with a distinctly darker reddish-brown portion at the distal end of the neck of each chamber.

Length up to 4 mm.

Distribution.—There are four *Challenger* records for this species, station 206, in 2,100 fathoms, west of Luzon, stations 237, 238, 246, in 1,875–3,950 fathoms, on the line east from Japan. Goës records the species from two *Albatross* stations off the west coast of Mexico and Central America, D3357 in 789 fathoms and D3415 in 1,879 fathoms, the specimens being small and scarce.

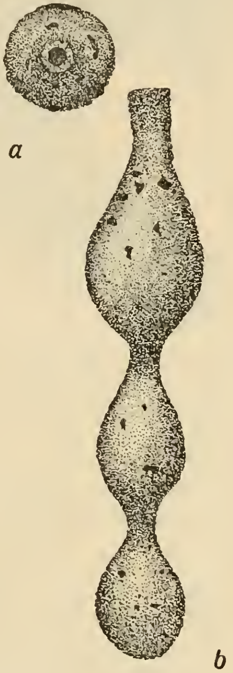


Fig. 138.—Hormosina ovicula. × 45. *a*, end view showing aperture; *b*, side view.

Goës speaks of the material as not typical, but while the specimens from the Caribbean Sea are not typical that from the Pacific is much more so. The figured specimen is from *Albatross* station D3915 and is very typical, even to the color bands of the neck of each chamber.

HORMOSINA NORMANII H. B. Brady.

Hormosina normanii H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 52; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 329, pl. 39, figs. 19–23.

Description.—Test composed of a few subspherical segments, earlier ones small, later ones much larger, irregularly arranged, aperture at the end of a tubular neck often near the entrance of the last previous aperture or at one side, walls very thin, smooth both without and within.

Length, 8 mm.

Distribution.—In the *Challenger* material this species occurs at three stations, 241, 244, 246, at 2,300, 2,900, and 2,050 fathoms, respectively, all in the one line of soundings east from Japan.

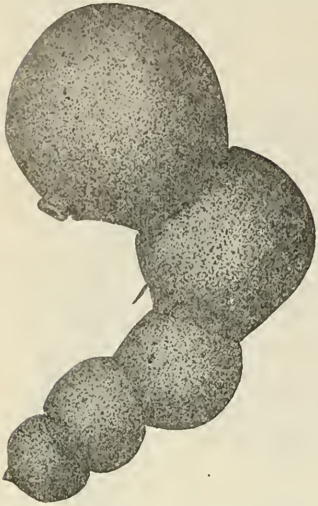


FIG. 139.—HORMOSINA NORMANII. × 10. (AFTER BRADY.)

Genus HAPLOSTICHE Reuss, 1861.

Nodosaria (part) D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 252.—REUSS, Vers. böhm. Kreide, vol. 1, 1845–1846, p. 26, pl. 13, figs. 12–13.

Lituola (part) JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 307.

Haplostiche REUSS, Sitzb. kön. böhm. Ges. Wiss., Jahrg. 1861, p. 16.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 317. Type, *H. fœdissima* REUSS, 1865.[a]

Description.—Test free, cylindrical, composed of a linear series of chambers, variously divided into labyrinthic cavities; walls thick, coarsely arenaceous but usually fairly smooth on the exterior; aperture in the middle of the terminal face, in the early chambers simple, in the adult made up of several pores or dendritic.

There seems to be but a single recent species occurring in shallow or medium depths usually in tropical or subtropical waters.

HAPLOSTICHE DUBIA (d'Orbigny).

"*Orthoceratia Zoophytica minuscula*." SOLDANI, Testaceographica, vol. 1, pt. 2, 1791, p. 93, pl. 98, fig. A.

Nodosaria dubia D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 252, No. 10.

Lituola dubia PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 263, pl. 9, fig. 30.

Lituola soldanii JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 307, no. 184.

Haplostiche soldanii H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 318, pl. 32, figs. 12–18.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 263, pl. 4, figs. 34, 35.—FLINT, Rep. U. S. Nat. Mus. 1897 (1899), p. 277, pl. 21, fig. 3.

Description.—Test free, cylindrical or fusiform, made up of a linear series of rather short chambers, usually straight; wall composed of coarse sand grains neatly cemented, thick, produced in the chamber and causing a labyrinthic condition; aperture in the early chambers a single opening, simple, in adults becoming cruciform, dendritic or in some cases the divisions are separated, giving several openings; color variable, usually light gray.

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[a] No type-species was designated by Reuss, but as his model was based upon *Dentalina fœdissima* Reuss 1861, that may best be taken as type.

Length up to 7.5 mm.; diameter up to 2 mm.

Distribution.—The only published record for this species in the North Pacific is that of Bagg, who recorded it from two *Albatross* stations in the vicinity of the Hawaiian Islands, D4000 in 104–213 fathoms and H4590 in 978 fathoms. I have found specimens in material from *Nero* station 2071 in 271 fathoms, also near the Hawaiian Islands and at *Albatross* station D. 4900 in 139 fathoms off Japan.

Figs. 140–141.—Haplostiche dubia × 7. From photograph.

The dendritic aperture is supposed to distinguish this species from any others that may be confused with it, but in the smaller specimens which have not attained adult characters the aperture is simple. The labyrinthic condition of the interior is also characteristic. As d'Orbigny's name is the first to be referred to the figure of Soldani, priority will make necessary the use of his name *dubia* instead of *soldanii* Jones and Parker.

Subfamily 3. TROCHAMMININÆ.

Test composed of several chambers, either in a planospiral coil, trochoid, or otherwise arranged, wall composed of sand grains of varying degrees of coarseness cemented with a calcareous or ferruginous cement, free or attached.

This subfamily as here used contains the many-chambered arenaceous forms not arranged in a linear series throughout. Except the large, somewhat anomalous form, *Neusina agassizii*, for which a separate subfamily has been made. Some of the species, such as *Ammobaculites tenuimargo*, appear to be largely made up of a linear series, but have a close coiled early portion not seen in the Reophacinæ.

TROCHAMMINOIDES, new genus.

Description.—Test free, typically planospiral, composed of several coils, each constricted into a number of chamber-like portions with the openings between large; wall of fine sand and a yellowish-brown cement; aperture simple at the end of the last-formed chamber.

Type of the genus.—*Trochammina proteus* Karrer.

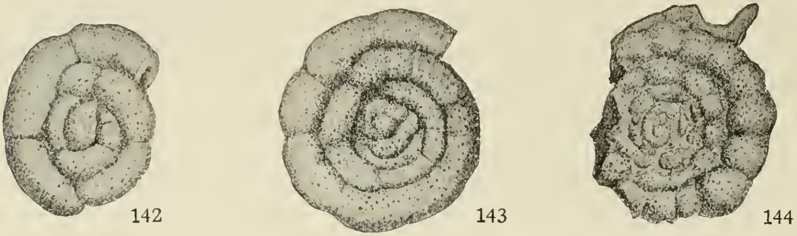
This species frequently shows a tendency to continue the *Ammodiscus* condition through one or more of the early coils, and the latter portion only may be divided, or in other specimens the divisions may occur much earlier. By its early development the genus is seen to have been derived from an *Ammodiscus* condition, as its early development consists of a proloculum and long coiled chamber as in *Ammodiscus*, but its later constricted condition foreshadows the condition of complete division seen in the chambered coiled forms usually assigned to *Haplophragmium* and *Trochammina*.

TROCHAMMINOIDES PROTEUS (Karrer).

Trochammina proteus Karrer, Sitzb. kais. Akad. Wiss. Wien, vol. 52 (Abth. 1), 1865 (1866), p. 494, pl., fig. 8 (not 1-7).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 341, pl. 40, figs. 1-3.—Haeusler, Neues Jahrb., Beil., vol. 4, 1885, p. 28, pl. 3, fig. 24 (25-27?).—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 266, pl. 5, figs. 7, 8 [?].—Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 694, fig. 42 (in text).—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 25, fig. 3.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 128.

Ammodiscus proteus Rhumbler, Arch. Protistk., vol. 3, 1903, p. 281, fig. 131 (in text).

Description.—Test of several coils, usually planospiral, each coil usually constricted to form several chambers, but the early coils sometimes unconstricted, wall composed of fine sand and a yellowish-brown or reddish-brown cement, fairly smooth, chambers variable in length, aperture large, with thickened lips.



Figs. 142-144.—Trochamminoides proteus. × 25 (after Brady).

Diameter 1-1.5 mm.

Distribution.—There are but two records for this species in the North Pacific, one *Challenger* station 224 in 1,850 fathoms, west of the Caroline Islands, and the other *Albatross* station H4566, at a depth of 572 fathoms, near the Hawaiian Islands, recorded by Bagg.

This species in its typical form is clearly divided into chambers of uniform size, especially in the last-formed coils, but the earlier coils may be undivided or irregularly constricted. Its development indicates the derivation of the many-chambered planospiral forms from a type like *Ammodiscus*.

The eight figures given by Karrer show various forms of tests, planospiral or involute, undivided tests belonging to *Ammodiscus* or *Gordiammina* and other trochoid divided tests like true *Trochammina* and in fig. 8 a test similar in form to the recent specimens placed under this specific name. Brady[a] has already noted the various forms grouped by Karrer under this species and has proposed the restriction of the name given by Karrer to the form represented by fig. 8 of Karrer. This seems reasonable, and I have adopted the same restriction.

Haeusler's figures also show various forms under this specific name. The specimen shown in fig. 24 may belong here, but the others are hardly this species as here restricted.

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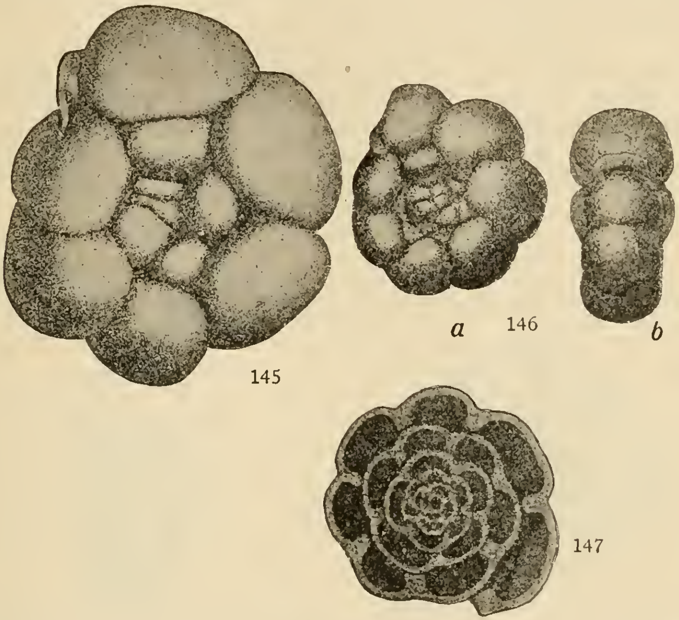
[a] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 341.

Genus HAPLOPHRAGMOIDES, new genus.

Description.—Test free, planospiral, composed of several coils, each composed of a number of chambers, wall arenaceous, varying much in texture and in the relative amount of cement in the different species, aperture at the ventral border or on the lower portion of the apertural face of the chamber.

Type of the genus.—*Haplophragmium canariense* d'Orbigny.

Included in this genus are the various completely coiled, planospiral, arenaceous species with simple apertures which have usually been assigned to *Haplophragmium* or *Trochammina*. The type-species of the former genus is an uncoiled form with multiple apertures, and the type-species of the latter genus has a trochoid spiral test. As here recognized, the species of this new genus have approximately an equal portion of the chambers of the test visible from the two sides. I have included here both the species with an excess of cement often assigned to *Trochammina* and those of coarser texture, which have been assigned to *Haplophragmium*.



Figs. 145–147.—Haplophragmoides coronata. × 20 (after Brady). 145, large specimen from side. 146 *a*, from side; *b*, apertural view. 147, section.

HAPLOPHRAGMOIDES CORONATA (H. B. Brady).

Trochammina coronata H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 58, pl. 5, fig. 15; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 340, pl. 40, figs. 10–12.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 26, fig. 3.

Description.—Test planospiral, fairly smooth, composed of three to six coils, the outer ones somewhat embracing, but all more or less visible from either side, chambers somewhat inflated, usually six to seven in the last-formed coil, distinct; aperture simple, at the ventral border of the apertural face, sometimes with traces of a lip present; wall composed of fine sand, usually with a reddish cement, but very variable in color, from white to brown.

Diameter 2–2.5 mm.

Distribution.—The only record for this species in the North Pacific is that of the *Challenger*, station 238, in 3,950 fathoms, east of Japan. This is the deepest sounding of the *Challenger* expedition from which material was examined.

HAPLOPHRAGMOIDES TRULLISSATA (H. B. Brady).

Trochammina trullissata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 56, pl. 5, figs. 10 *a*, *b*, 11; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342, pl. 40, figs. 14-16 (not fig. 13).—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 64, pl. 10, figs. 9, 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 265, pl. 5, figs. 25, 26 [?].—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 18.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 33.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 364.

Description.—Test spirally coiled, made up of about three coils, not completely involute, somewhat umbilicate, so that the chambers of early coils are visible at the center, usually about nine chambers in the last-formed coil, chambers subglobular, aperture slightly above the base of the apertural face of the chamber, elongate, test smoothly finished exteriorly; color yellowish or reddish brown.

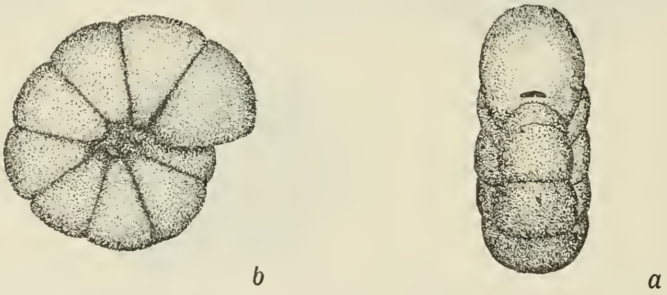


FIG. 148.—HAPLOPHRAGMOIDES TRULLISSATA. × 75. SPECIMEN FROM 2,875 FATHOMS, *Albatross* STATION H2916. *a*, SIDE VIEW; *b*, APERTURAL VIEW OF SAME SPECIMEN.

Diameter, 1–1.25 mm.

Distribution.—This species is recorded from six widely distributed *Challenger* stations in the North Pacific, varying in depth from 1,850–3,950 fathoms. Goës records it from three *Albatross* stations in the eastern Pacific at the entrance to the Gulf of California and off Panama in 978–1,218 fathoms. In the material I have examined, it has occurred at *Albatross* station H2916 in 2,878 fathoms near the Hawaiian Islands; at two *Nero* stations, 1014 in 1,987 fathoms, and 1085 in 2,360 fathoms, both north of Guam. In this same general region at *Alert* station 1169 the species was found in 2,113 fathoms.

As a rule, this seems to be a decidedly deep-water species, as the additional records of this work confirm. Specimens never seem to be plentiful, occasional specimens occurring in the washed material from these stations.

HAPLOPHRAGMOIDES CANARIENSIS (d'Orbigny).

Nonionina canariensis d'Orbigny in Barker-Webb and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, Foraminifères, 1839, p. 128, pl. 2, figs. 33, 34.

Placopsilina canariensis Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 301, pl. 10, figs. 13, 14.

Lituola canariensis W. B. Carpenter, Parker, and Jones, Intr. Study Foram., 1862, pl. 6, figs. 39, 40, 41.—H. B. Brady, Trans. Linn. Soc. London, vol. 24, 1864, p. 472.—Carter, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, pl. 13, figs. 26–29.

Lituola nautiloidea, var. *canariensis* Parker and Jones (part), Trans., Roy. Soc. London, vol. 155, 1865, p. 406, pl. 15, figs. 45*a*, *b*; pl. 17, figs. 92–95.

Haplophragmium canariensis Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 4.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 192, pl. 5, fig. 17.—H. B. Brady, Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 99; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 310, pl. 35, figs. 1–5.—Haeusler, Neues Jahrb., vol. 4, 1885, p. 12, pl. 1, figs. 17–20.—H. B. Brady, Parker and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 218, pl. 41, fig. 9.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1888, p. 330.—Haeusler, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 34, pl. 4, figs. 1–3.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 261, pl. 5, figs. 27–29.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 20, pl. 5, figs. 92–101.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—Chapman, Ann. Mag. Nat. Hist., ser. 6, vol. 16, 1895, p. 314, pl. 11, fig. 5; Proc. Zool. Soc. London, 1895, p. 16.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 30.—Millett, Journ. Roy. Micr. Soc., 1899, p. 359.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 277, pl. 20, fig. 3.—Chapman, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 84; Journ. Queckett Micr. Club, vol. 10, 1907, p. 126, pl. 9, fig. 3.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

Nonionina jeffreysii Williamson, Recent Foraminifera of Great Britain, 1858, p. 34, pl. 3, figs. 72, 73.

Haplophragmium jeffreysii Berthelin, Foram. de Bourgneuf et Pornichet, 1878, p. 24, No. 20.

Description.—Test free, nautiloid, composed of several coils partially involute or almost completely so, umbilicated, chambers subglobular, somewhat compressed laterally, from six to nine in each coil, walls arenaceous, made up of sand in various degrees of coarseness, but even when coarse usually fairly smooth on the exterior, thin, aperture an elongated slit-like opening at the base of the apertural face of the chamber; color brown or gray, often when brown the last formed chamber may be gray.

Diameter, 0.75–2 mm.

Distribution.—There are a considerable number of records for this species in the North Pacific. The *Challenger* report gives seven stations ranging from 1,850–3,950 fathoms, with one station on the coral reefs of Honolulu at 40 fathoms. Goës records it at three *Albatross* stations off the coasts of Mexico and Central America in 660–1,879 fathoms. Flint records it from a single station, *Albatross* D3080, in 93 fathoms off the coast of Oregon. Bagg records it from two *Albatross* stations, H4566 in 572 fathoms and H4696 in 367 fathoms, both stations near the Hawaiian Islands. In the present work I have had specimens from *Albatross* station D3431 off California, D4965, D4993, D5068, 77–191 fathoms off the coast of Japan; *Nero* stations 1308, 1311, in 1,040 and 1,503 fathoms near the Bonin Islands. Specimens were also obtained from the stomachs of Holothurians taken at *Albatross* station D3608 in Bering Sea.

There is a considerable variation in the texture of the wall, some specimens being smooth and of very fine material, resembling certain species of *Trochammina*, while others are of much coarser material. In general, however, the exterior of the test is smoothly finished. A considerable variety of forms have been assigned to this species by various authors, but I have placed here only those specimens which have the somewhat compressed form with the rounded chambers, which are characteristic of d'Orbigny's type figure.

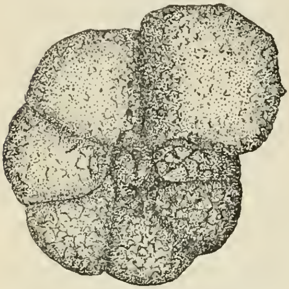


Fig. 149.—Haplophragmoides canariensis. × 20.

HAPLOPHRAGMOIDES EMACIATUM (H. B. Brady).

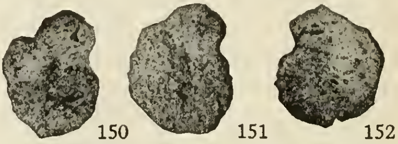
Haplophragmium emaciatum H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 305, pl. 33, figs. 26–28.—Chapman, Proc. Zool. Soc. London, 1895, p. 16.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 262, pl. 5, figs. 53, 54.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 276, pl. 19, fig. 5.

Haplophragmium compressum Millett [not *Haplophragmium compressum* Goës], Journ. Roy. Micr. Soc., 1899, p. 359, pl. 5, fig. 8.

Description.—Test nautiloid, planospiral, laterally compressed, consisting of two or more coils, chambers slightly involute, seven or eight in the last formed coil, usually rather indistinctly marked on the exterior; wall rather coarsely arenaceous, often with sponge spicules cemented into the test, aperture an elongated slit at the base of the apertural face; color usually brownish or gray.

Diameter 1–1.5 mm.

Distribution.—There are apparently no published records for this species in the North Pacific. In the *Albatross* and *Nero* collections the species occurs at several stations. Single specimens were obtained from three *Albatross* stations off Japan, D4970 in 500 fathoms, D4979 in 943 fathoms, and D5086 in 292 fathoms. Single specimens were obtained from two *Nero* stations, 12 off the Hawaiian Islands, 1,924 fathoms, and 172 in 2,086 fathoms near



Figs. 150-152.—Haplophragmoides emaciatum. × 20. From photograph.

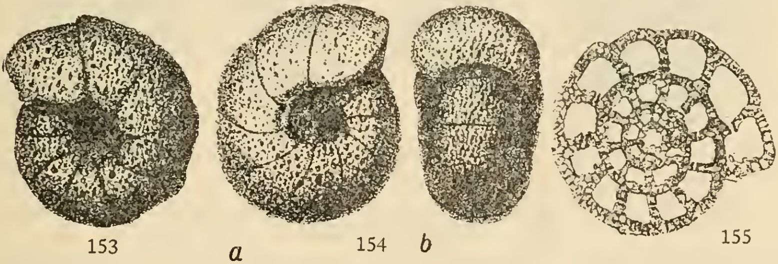
Midway Island. A single specimen from *Alert* station 1178 in 623 fathoms off San Augustino Island, belongs to this species.

From the series of specimens I have been able to obtain for study it seems a questionable point as to whether *H. compressum* of Goës is really the same as *H. emaciatum* H. B. Brady. As far as I have observed there is no tendency for any of the Pacific specimens to uncoil in later growth, and the aperture always remains a slit at the base of the apertural face. In the West Indian material which may be referred to *H. compressum* Goës there is a decided tendency to uncoil and a coincident change in the position of the aperture occurs. The specimen figured by Millet seems to be a close-coiled form and is included here.

HAPLOPHRAGMOIDES SCITULUM (H. B. Brady).

Haplophragmium scitulum H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 308, pl. 34, figs. 11–13.—Chapman, Proc. Zool. Soc. London, 1895, p. 16.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 276, pl. 20, fig. 2.

Description.—Test nautiloid, planospiral, consisting of about three coils, not completely involute so that at the umbilical region the earlier coils are exposed; wall composed of firmly cemented sand grains; from seven to eleven chambers make up the last-formed coil, the chambers being wide and broadly rounded at their peripheral edge give the whole test a much broader form than seen in *H. canariense;* chambers nearly flush with one another, giving a fairly even periphery to the test, aperture a somewhat curved slit at the base of the apertural face; color of the test various shades of brown.



Figs. 153–155.—Haplophragmoides scitulum. × 40 (after Brady). 153, side view. 154*a*, side view; *b*, apertural view. 155. section.

Diameter 0.75–1 mm.

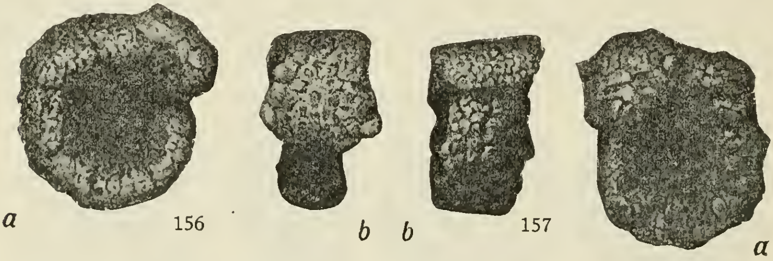
Distribution.—This species seems to be rare in the North Pacific. In the *Challenger* report it is recorded but once, from station 244 in 2,900 fathoms. Bagg records it from four *Albatross* stations in the vicinity of the Hawaiian Islands, 367–1,544 fathoms. I have seen material from but four other *Albatross* stations, D3431, at the entrance to the Gulf of California, 995 fathoms; H2774, off the California coast in 469 fathoms; D5018, in 100 fathoms in the Okhotsk Sea; and D4998 in 66 fathoms in the Gulf of Tartary off the southwestern coast of Sakalin Island, bottom temperature 35.9° F.

This species seems to be distinct from *H. canariense* and may be distinguished by its broader form, more deeply excavated umbilici, and the wider, flattened chambers.

HAPLOPHRAGMOIDES ROTULATUM (H. B. Brady).

Haplophragmium rotulatum H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 306, pl. 34, figs. 5, 6.—Chapman, Proc. Zool. Soc. London, 1895, p. 16.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 261, pl. 5, figs. 43, 44.

Description.—Test nautiloid, planospiral, composed of about three coils, wall fairly thick, of rather coarse sand particles, slightly rough on the exterior, chambers very broad and low, the peripheral margin much flattened, somewhat involute but the preceding coils exposed at the umbilical region, deeply concave on each side at the umbilici; chambers about nine in the last-formed coil, but rather indistinct when viewed from the exterior; aperture a narrow slit at the base of the apertural face; color brown.



FIGS. 156–157.—HAPLOPHRAGMOIDES ROTULATUM. × 50 (AFTER BRADY). *a, a,* FRONT VIEWS; *b, b,* APERTURAL VIEWS.

Diameter 0.56–0.75 mm.

Distribution.—Brady gives but a single North Pacific station, *Challenger* station 244 in 2,900 fathoms, but the volume on the "Summary of Results" adds two *Challenger* stations, 237 in 1,875 fathoms and 246 in 2,050 fathoms. The only specimen I have seen referable to this species is a single one from the coast of California, *Albatross* station H2681 in 486 fathoms, and this may perhaps be an extremely broad form of *H. scitulum.*

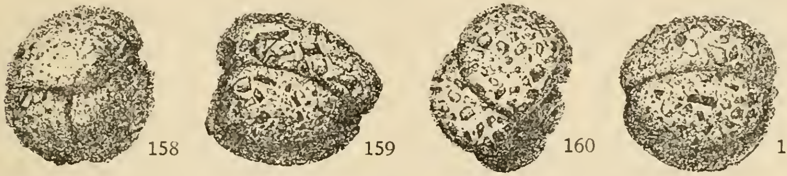
HAPLOPHRAGMOIDES GLOMERATUM (H. B. Brady).

Lituola glomerata H. B. Brady, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433, pl. 20, figs. 1*a–c*.

Haplophragmium glomeratum Wright, Proc. Belfast Field Club, 1880–81 (App.), p. 180, pl. 8, figs. 1, 1*a*.—H. B. Brady. Denkschr. kais. Akad. Wiss. Wien, vol. 43, 1881, p. 100; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 309, pl. 34, figs.

15–18.—Balkwill and Millett, Journ. Micr. and Nat. Sci., vol. 3, 1884, p. 25, pl. 1, fig. 6.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1885, p. 329.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 23, pl. 5, figs. 134–136 [not figs. 137–139].—Chapman, Proc. Zool. Soc. London, 1895, p. 15.

Description.—Test planospiral, composed of about two coils, chambers very low and broad making a subglobose test, usually three or four chambers making up the last-formed coil, slightly concave at the umbilici, wall coarsely arenaceous, rather rough, thin; aperture at the base of the apertural face consisting of a short slit which is often obscured by sand grains; color variable, depending largely upon the material composing the test.



Figs. 158–161.—Haplophragmoides glomeratum. × 100 (after Brady).

Diameter 0.25–0.75 mm.

Distribution.—Brady gives but one North Pacific *Challenger* station for this species, off the Philippines in 2,550 fathoms. The volume on the "Summary of Results" also gives a record off Japan, *Challenger* station 237 in 1,875 fathoms.

A number of specimens from *Nero* station 1295, in 1,415 fathoms between Yokohama and Guam, are possibly this species. Otherwise I have seen no North Pacific material referable to it.

HAPLOPHRAGMOIDES SUBGLOBOSUM (G. O. Sars.)

Lituola subglobosa M. Sars, Forh. Vid. Selsk. Christiania, 1868 (1869), p. 250, (*nomen nudum*).—G. O. Sars, Forh. Vid. Selsk. Christiania, 1871 (1872), p. 253.

Haplophragmium subglobosum H. B. Brady, Denkschr. kais. Akad. Wiss. Wien, vol. 43, 1881, p. 100; Ann. Mag. Nat. Hist., ser. 5, vol. 8, 1881, p. 406.

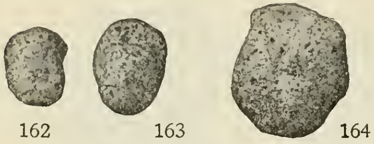
Haplophragmium latidorsatum H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 307, pl. 34, figs. 7, 8, 10, 14 [?] (not fig. 9), and subsequent authors (not *Nonionina latidorsata* Bornemann, 1855).

Description.—Test usually planospiral consisting of two or more coils, involute, depressed at the umbilici, chambers very broad and low, wall arenaceous somewhat roughened but variable, chambers usually seven or eight in the last-formed coil, making the test as a whole subglobose, aperture a more or less elongated slit at the base of the apertural face, simple; color gray or brown.

Diameter 1–2.5 mm.

Distribution.—As *Haplophragmium latidorsatum* this species has been widely recorded. There are given eleven *Challenger* stations in the North Pacific for this species, ranging from 1,850–3,950 fathoms. Goës records it at several *Albatross* stations off the west coast of Mexico and Central America in 772–1,879 fathoms. Bagg gives four stations near the Hawaiian Islands, 367–1,342 fathoms. From the *Albatross* and *Nero* material I have examined this species is noted from many stations; *Albatross* D3603, from Holothurian stomachs, specimens taken in 1,771 fathoms in Bering Sea; from H3012 in 2,067 fathoms, between California and Hawaii; D4832, D4957, D4958 in 76, 437, and 405 fathoms, respectively. It occurred at a number of *Nero* stations in the dredgings from the Hawaiian Islands west across the Pacific, the depths varying from 1,040 to 2,226 fathoms.

The work of Brady in referring to *Nonionina latidorsata* Bornemann the recent species so common in the Arctic has been followed by most later writers. After a careful study of Bornemann's original figure and description I am unable to find clear enough reasons for giving Bornemann's name to our species. The figure and description call for a test which has high compressed chambers with the apertural face quadrangular, while in recent specimens the apertural face of the last chamber is typically very much wider than high. The form of the test is usually more globose than in Bornemann's figure and the test presents a very different appearance. As it is definitely known what the types of *subglobosum* are and as they are typical of the recent material it has seemed to me better to use Sars's name rather than to refer all our recent material to a rather indefinite fossil species.



Figs. 162–164.—Haplophragmoides subglobosum. × 16. From photograph. 163. Apertural view.

The form with its aperture consisting of a number of pores which is included by Brady under *Haplophragmium latidorsatum* seems to be very distinct, and as far as the North Pacific material is concerned has a definite distribution. It will be considered there as generically distinct from the planospiral forms with simple apertures.

I have not attempted to give the complete synonymy as many later authors have referred specimens to *Haplophragmium latidorsatum* without figures or description, and without seeing the original material a clearing up of the synonymy is impossible.

In the North Pacific this species seems to be common in cold or deep waters and is well distributed, being perhaps the most common of the chambered arenaceous forms.

HAPLOPHRAGMOIDES SPHÆRILOCULUM, new species.

Description.—Test free, nautiloid, planospiral, consisting of five chambers in the last-formed coil, partially involute, chambers very globose, inflated, sutures depressed, peripheral margin of test deeply indented, aperture at the base of the apertural face; wall of fine arenaceous material smoothly cemented; color yellowish-brown.

Diameter about 1 mm.

Type-specimen.—Cat. No. 8218 U.S.N.M., from *Albatross* station D4970 in 500 fathoms off Japan. Another specimen was found in material from *Albatross* station D4957 in 437 fathoms, also off Japan.

This species differs from other planospiral arenaceous forms in the spherical character and position of the chambers, which are well separated so that their globose character is given its full value in shaping the test.

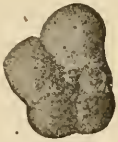


Fig. 165.—Haplophragmoides sphæriloculum. × 30. From photograph.

HAPLOPHRAGMOIDES RINGENS (H. B. Brady).

Trochammina ringens H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 57, pl. 5, figs. 12*a*, *b*; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 343, pl. 40, figs. 17, 18.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 33.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 27, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1899, p. 365, pl. 5, fig. 14 [?].—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 129.

Ammochilostoma ringens Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 692.

Description.—Test spirally coiled, planospiral, of few coils, chambers usually completely involute covering the previously formed coils, chambers high, narrow, biconvex, usually with 3–5 in the lastformed coil; the last-formed chamber being much higher than preceding ones, peripheral edge somewhat sharp, surface smooth and polished, aperture slightly arcuate, somewhat above the base of the apertural face usually in a sort of depression of the wall; color various shades of brown.

Longer diameter 1.5 mm.

Distribution.—Although Brady states in his volume of the *Challenger* "Report" that the species seems to be limited to the Atlantic, in the volume on the "Summary of Results" this species is recorded from station 237, 1,875 fathoms, off Japan. Goës records this species as very scarce from a single *Albatross* station off Panama, D3375 in 1,201 fathoms. Flint records it from another *Albatross* station, D2923, in 822 fathoms off California.

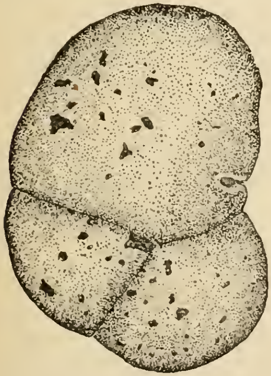


Fig. 166.—Haplophragmoides ringens. × 45.

Bagg records it from a single *Albatross* station near the Hawaiian Islands, H4590, in 978 fathoms, rare. I have found specimens from two North Pacific stations, *Albatross* D4979, off Japan, in 943 fathoms, and from *Alert* station 1156 in 2,046 fathoms south of Japan, near the Bonin Islands.

This seems to be a rare species and to occur in small numbers when found. In its earlier development the chambers are somewhat less flattened and of nearly equal height in the coil, but in the later development the chambers become high and the last-formed chamber in the adult is often much longer than any of the preceding ones.

The specimen figured by Millett is not typical, the last-formed chamber being of very different form from that usually seen in the specimens I have examined.

CRIBROSTOMOIDES, new genus.

Haplophragmium H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 307.

Description.—Test free, planospiral, of several coils, chambered, the last-formed coil with several chambers progressively increasing in size, arenaceous wall, with much cement usually of a light-brown color, aperture in young specimens a simple elongate slit at the base of the apertural face, later subdivided by tooth-like processes, and in the adult represented by a linear series of distinct rounded openings.

Type of genus.—*Cribrostomoides bradyi,* new species.

This genus, while in general character is similar to *Haplophragmoides*, differs very distinctly in the apertural characters and in their development.

CRIBROSTOMOIDES BRADYI, new species.

Haplophragmium latidorsatum H. B. Brady (part), (not Bornemann), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 307, pl. 34, fig. 9.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 29 (part).

Description.—Test free, nautiloid, rotund, large, composed of seven to nine rotund chambers in the outer visible coil, umbilicate on both sides, wall composed of very fine arenaceous material with much cement, surface smooth, even; in front view broad, chambers rather low but broad, involute, aperture at first an elongate curved slit, later with the growth of tooth-like projections from the two sides it becomes subdivided so that in adult specimens the aperture is really multiple, consisting of a linear series of rounded openings instead of a single slit, color light grayish or yellowish brown.

Diameter up to 3 mm.

Distribution.—Specimens of this species were found in the Goës collection, his series of specimens from *Albatross* station D3419 in 772 fathoms being all of this species, but labeled "*Haplophragmium latidorsatum.*" In the same general region, the west coast of Mexico and the United States, the species has occurred in quantity at *Albatross* station D3346 off Washington, 786 fathoms, and at station D3431 in the Gulf of California, 995 fathoms. As is the case with many of our west coast species of foraminifera, this species is again seen in material from the coast of Japan. It occurred at *Albatross* station D4975 in 712 fathoms, and D5078, in 514 fathoms. Specimens, possibly the young of this species, were obtained at two *Nero* stations 1184 and 1287, in 1,542 and 1,606 fathoms.

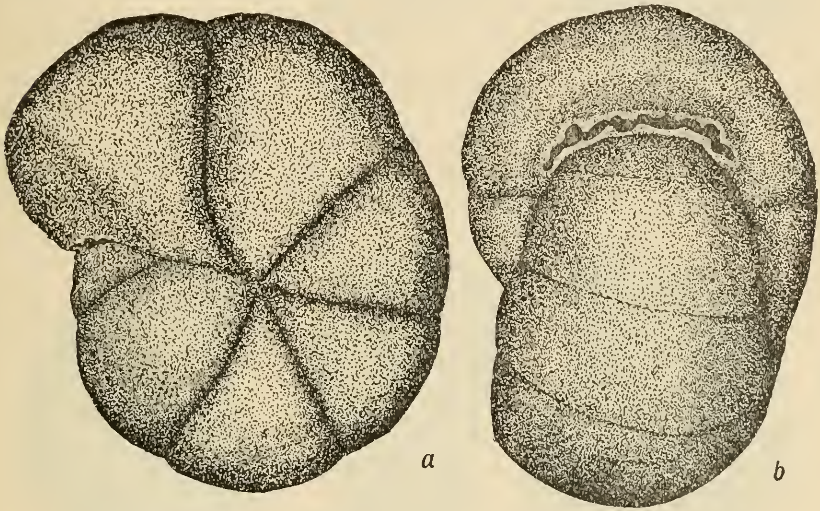


FIG. 167.—CRIBROSTOMOIDES BRADYI. × 20. *a*, SIDE VIEW; *b*, APERTURAL VIEW.

A large series of specimens like that from *Albatross* station D. 3346 shows that this is a very different species from any of the described forms to which it has usually been united. The characters in the material studied are little modified by variation.

Genus CYCLAMMINA H. B. Brady, 1876.

Lituola W. B. CARPENTER (part), The Microscope, 5th ed., 1875, p. 536.—CARTER, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 203.

Cyclammina H. B. BRADY (MS.) in NORMAN, Proc. Roy. Soc. London, vol. 25, 1876, p. 214; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 350. Type, *Cyclammina cancellata* H. B. BRADY.

Description.—Test free, composed of numerous chambers in a close-coiled nautiloid series, final revolution usually completely embracing the preceding ones except at the umbilicus; walls thick, composed of fine arenaceous material with a reddish-brown cement, exterior smooth, chambers with secondary labyrinthic structures interiorly, especially on the peripheral portion of each chamber, early chambers often becoming completely filled by this secondary growth; aperture a curved fissure at the proximal portion of the apertural face, supplemented by numerous pores on the apertural wall itself.

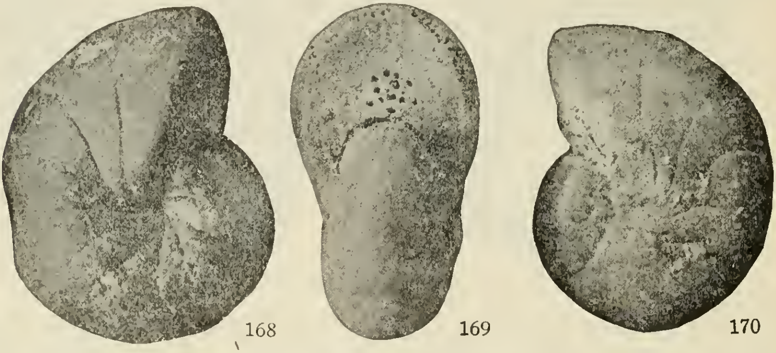
CYCLAMMINA CANCELLATA H. B. Brady.

"Nautiloid *Lituola*" W. B. Carpenter, The Microscope, 5th ed., 1875, p. 536, figs. 274*a*, *b*, *c* (in text).

Cyclammina cancellata H. B. Brady (MS.) in Norman, Proc. Roy. Soc. London, vol. 25, 1876, p. 214; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 62; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 351, pl. 37, figs. 8–16.—Agassiz, Bull. Mus. Comp. Zoöl., vol. 29, 1888, p. 164, figs. 498, 499 (in text).—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 470.—Chapman, Proc. Zool. Soc. London, 1895, p. 18.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 32.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 282, pl. 27, fig. 3; pl. 28, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 129.

Lituola canariensis Carter, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 203, pl. 13, figs. 26–29.

Description.—Test nautiloid, biconvex or slightly more convex at one side, umbilicated, chambers numerous, averaging about thirteen chambers in the last-formed coil, usually about three full coils in the adult test; sutures seen from the side somewhat curved anteriorly in the middle; exterior smooth and imperforate when perfect, interior of the chambers labyrinthic, the structure thus formed almost or quite filling the earlier developed chambers, peripheral edge of test rounded, with little trace of depressions at the sutures of the chambers; aperture an elongated slit near the base of the apertural face, supplemented by a series of pores occupying the central part of the apertural face, often becoming very numerous in very large specimens; color reddish-brown.



Figs. 168–170.—Cyclammina cancellata. × 16. From photograph. 169. Apertural view. The megalospheric form of the species with fewer chambers in each whorl, and attaining, when fully developed, a smaller size than that of the microspheric form.

Diameter up to 6.5 mm.

Distribution.—The *Challenger* obtained this species at stations 237 and 244 in the North Pacific east from Japan, in 1,875 and 2,900 fathoms. Goës records it from three *Albatross* stations off the coast of Mexico, 660–995 fathoms. Bagg records it from two stations in the vicinity of the Hawaiian Islands, 495 and 865 fathoms. Flint records it from *Albatross* station D2860 in 876 fathoms off the coast of British Columbia. I have found the species in material from *Albatross* station D3346 in 786 fathoms off Oregon, H1135 in 2, 848 fathoms just south of Unalaska, Aleutian Islands, and twice in the vicinity of Japan, D4900 and D4975, in 139 and 712 fathoms.

As a rule, this species seems to be found in cold and rather deep water, following rather well the faunal lines already spoken of in the introduction.

The microspheric form of the species grows to a large size with more complicated labyrinthic structures and apertures. The megalospheric form is smaller and less complicated in its structure. The two forms are shown in Flint's plates, plate 27, fig. 3, showing the microspheric form, plate 28, fig. 1, the megalospheric. The megalospheric proloculum is considerably larger than that of the microspheric form.

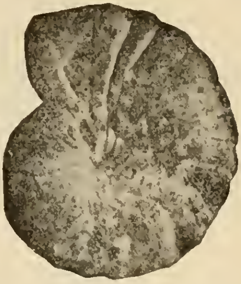


FIG. 171.—CYCLAMMINA CANCELLATA. × 8. FROM PHOTOGRAPH. THE MICROSPHERIC FORM OF THE SPECIES WITH A LARGER NUMBER OF CHAMBERS IN THE ADULT WHORLS AND ATTAINING A LARGER SIZE THAN THE MEGALOSPHERIC FORM.

CYCLAMMINA PUSILLA H. B. Brady.

Cyclammina pusilla H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 53.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 32, pl. 6, figs. 242–244.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 18.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 32.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 282, pl. 28, fig. 2.

Description.—Test nautiloid, small, compressed, umbilicate, peripheral edge rather thin, almost keeled in some specimens, often lobulated by successive chambers, composed of three coils, the last-formed one enveloping the others except at the umbilicus; wall finely arenaceous, inclined to be porous, especially within, but not building definite labyrinthic structures; aperture a curved slit at the base of the apertural face; color reddish-brown.

Diameter 0.5–1.5 mm.

Distribution.—There are two *Challenger* records for this species, stations 237 and 246, at 1,875 and 2,050 fathoms, one east of Japan, the other in the middle of the North Pacific. Goës found the species at two *Albatross* stations in the eastern tropical North Pacific in 772–1,201 fathoms. Flint records this species from *Albatross* station D3080, off the coast of Oregon, in 93 fathoms. I have found specimens at one station near the Hawaiian Islands, *Nero* station 2032 in 1,014 fathoms; also at three *Nero* stations 1134, 1305, 1308, near the Bonin Islands in the northwestern Pacific, 2,879, 1,289, and 1,040 fathoms; and at two *Albatross* stations of the 1902 cruise, D4957 D4958, at 405 and 437 fathoms, off the south coast of Japan.

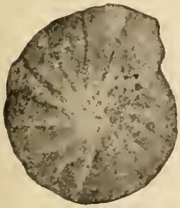


FIG. 172.—CYCLAMMINA PUSILLA. × 25. FROM PHOTOGRAPH.

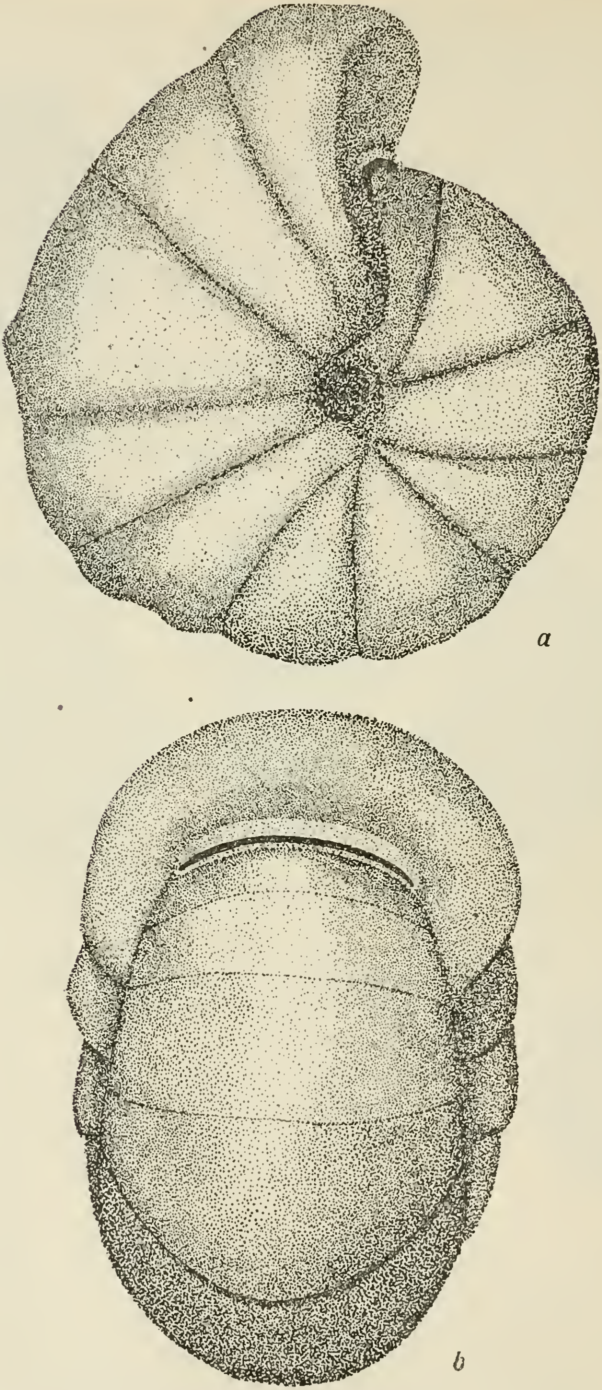


FIG. 173.—CYCLAMMINA ORBICULARIS. × 35. *a*. SIDE VIEW; *b*, APERTURAL VIEW.

As in the case of the preceding species this is limited to the deeper and colder waters, as far as the records show.

CYCLAMMINA ORBICULARIS H. B. Brady.

Cyclammina orbicularis H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 53; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 353, pl. 37, figs. 17–19.

Description.—Test nautiloid, subglobose, hardly umbilicate, peripheral edge rounded, composed usually of less than two complete coils, the outer one completely hiding those previously developed, wall finely arenaceous, somewhat labyrinthic within; aperture a curved slit at the base of the apertural face; color reddish-brown.

Diameter 1.5–2 mm.

Distribution.—There are four specimens in the Goës material from *Albatross* station D3419, 772 fathoms off the west coast of Mexico, that seem to belong to this species. A specimen from *Nero* station D1204, in 846 fathoms off Japan, may be the young of this species.

CYCLAMMINA BRADYI, new species.

Trochammina trullissata H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342, pl. 40, fig. 13 (not 14, 15).

Description.—Test free, spiral, nearly completely involute, compressed, slightly excavated at the umbilicus, last volution with six to nine chambers, smooth on the exterior, aperture crescentiform at the base of the apertural face, not included in the wall but between it and the preceding volution; apertural face occasionally with perforations in adult specimens; color yellowish or reddish brown.

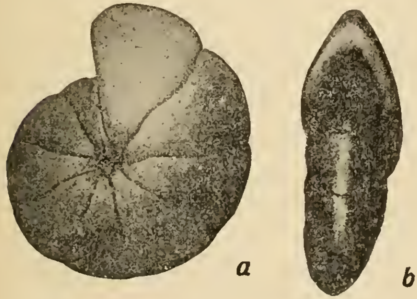


Fig. 174.—Cyclammina bradyi. × 30 (after Brady). *a*, side view; *b*, apertural view.

Diameter 1.2–1.5 mm.

Distribution.—Single specimens occurred at two *Nero* stations, 1134 in volcanic mud, 2,879 fathoms, and station 1305 in globigerina ooze, in 1,289 fathoms.

The specimen figured by Brady as *Trochammina trullissata*, referred to above, seems to belong here. It is evidently a *Cyclammina* in its characters and very different from the other specimens figured as *T. trullissata*. This species is at once distinguished from the young of *Cyclammina cancellata* and from *C. pusilla* by the smaller number of chambers in each volution.

Type-specimen.—Cat. No. 8212, U.S.N.M.

Genus LITUOTUBA Rhumbler, 1895.

Trochammina (part) H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342.

Lituotuba Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 83. Type, *L. lituiformis* (H. B. Brady) = *Trochammina lituiformis* H. B. Brady.

Description.—Test of two distinct parts, an early close-coiled portion and a long tubular uncoiled later portion; wall arenaceous, with an excess of cement, either indistinctly or irregularly divided.

This genus seems related, on the one hand, to *Ammodiscus* through such a form as *Trochamminoides proteus* (Karrer), but shows a definite senescent character in its uncoiled form. Besides certain fossil species this genus includes the following recent species:

LITUOTUBA LITUIFORMIS (H. B. Brady).

Trochammina lituiformis H. B. Brady, Quart. Journn. Micr. Sci., vol. 19, 1879, p. 59, pl. 5, fig. 16; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342, pl. 40, figs. 4-7.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 26, fig. 1.—Bagg, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 128.

Lituotuba lituiformis Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.

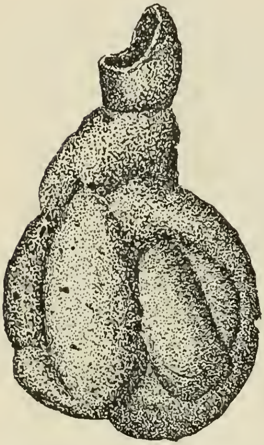


Fig. 175.—Lituotuba lituiformis. × 50.

Description.—Test composed of a close-coiled early portion and a later uncoiled portion, straight and tubular; irregularly or indistinctly divided into chambers; wall arenaceous with an excess of cement, aperture at the end of the tubular portion; color yellowish-brown.

Length up to 3.7 mm.

Distribution.—Bagg records a single specimen of this species from *Albatross* station D4000 in 104–213 fathoms near the Hawaiian Islands. Single specimens have occurred at two *Nero* stations, 1330 in 1,543 fathoms, and 1439 in 1,901 fathoms, in the western North Pacific, north of Guam.

This species appears to be rare in the North Pacific, but three specimens having been obtained from the dredgings.

Genus AMMOBACULITES, new genus.

Spirolina (part) d'Orbigny, Foram. Foss. Vienne, 1846, p. 137.

Haplophragmium (part) H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 301.

Description.—Test free, chambered, early portion close coiled in one plane, later portion uncoiled and made up of a more or less linear series of chambers; wall coarsely arenaceous, fairly thick; aperture single at the center of the terminal face of the uncoiled portion, but in the coiled portion at the base of the apertural face.

This genus is more like the typical *Haplophragmium* described by Reuss, but although it is uncoiled in later growth it does not have the multiple apertures or the interior structure of that genus. It is evidently derived from the genus *Haplophragmoides* and its early development is similar to that genus. The true *Haplophragmium* is represented in the recent ocean by few species which have the multiple apertures and the other characters of the genus, but they are to be distinguished from the species included under this genus.

Type.—*Ammobaculites agglutinans* (d'Orbigny).

AMMOBACULITES AGGLUTINANS (d'Orbigny).

Spirolina agglutinans D'ORBIGNY, Foram. Foss. Vienne, 1846, p. 137, pl. 7, figs. 10–12.

Haplophragmium agglutinans H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 301, pl. 32, figs. 19–26.—HAEUSLER, Neues Jahrb., Beil., vol. 4, 1885, p. 13, pl. 1, figs. 22, 23; pl. 2, figs. 3, 4.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 330, pl. 13, figs. 18–20.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 484, pl. 11, fig. 8.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 32, pl. 3, figs. 32, 36; pl. 4, figs. 5, 6, 18.—FORNASINI, Foram. Plioc. Pont. Savena, pl. 2, fig. 5.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 324, pl. 5, fig. 14.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 260, pl. 4, figs. 16, 36.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 23, pl. 5, figs. 140, 141.—CHAPMAN, Ann. Mag. Nat. Hist., vol. 16, 1895, p. 313, pl. 11, fig. 2; Proc. Zool. Soc. London, 1895, p. 16.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 32.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 357, pl. 5, fig. 1.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

Haplophragmium calcareum FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 275, pl. 19, fig. 1 (not *H. calcareum* d'Orbigny).

Description.—Test free, elongate, early portion closely coiled, planospiral, of one or more volutions, each with five to seven chambers, later portion uncoiled, made up of a linear series of chambers, in adult specimens making up the larger portion of the test, wall rather coarsely arenaceous, variable in its surface, sometimes fairly smooth, sometimes rough; aperture in the early chambers at the base of the apertural face, but in the uncoiled portion in the middle of the terminal face, single, circular; color very variable from light to dark gray or brown.

Diameter of coiled portion about 1 mm., total length up to 3 mm.

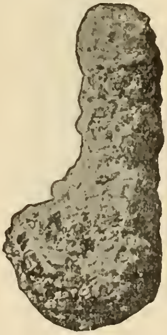


FIG. 176.—AMMOBACULITES AGGLUTINANS. × 25. FROM PHOTOGRAPH.

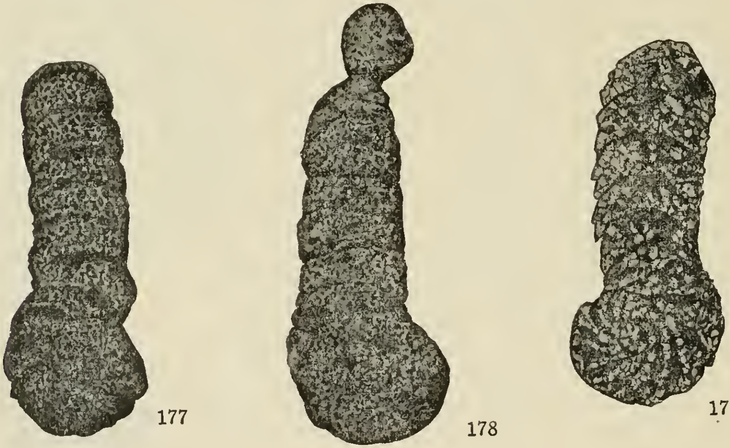
Distribution.—Brady records this species from five *Challenger* stations in the North Pacific, giving the depths as 7–3,125 fathoms. I am unable to find a record giving the shallowest station, but the other four range as follows: 2,050, 2,300, 2,900, and 3,125 fathoms, showing that it occurred as a rule in deep water. Bagg records the species from one station near the Hawaiian Islands, *Albatross* D4174, in 735–865 fathoms. I have found specimens of this species from six North Pacific stations. Single specimens were obtained from three *Albatross* stations near the Hawaiian Islands—H2764 in 122 fathoms, H2999 in 549 fathoms, and H3009 in 603 fathoms. It was obtained in material taken from the stomachs of Holothurians dredged at *Albatross* station D3603, 1,771 fathoms in Bering Sea, and at two *Nero* stations—1308 in 1,040 fathoms and 1410 in 1,144 fathoms—between Yokohama and Guam.

The early chambers of this species are not compressed as in the following species, but are of nearly equal diameter to those of the uncoiled portion. The species is represented by few specimens, but seems to be well distributed. There is some considerable variation in the color and texture of the material forming the wall. There is usually a rather small amount of cement visible, so that the finish of the surface of the wall depends upon the character of the material. Where the wall is smooth the chambers may easily be made out, but in the rougher specimens it is hard to distinguish their limits.

AMMOBACULITES FOLIACEUS (H. B. Brady).

Haplophragmium foliaceum H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 304, pl. 33, figs. 20–25.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 276, pl. 19, fig. 6.

Description.—"Test crosier-shaped, complanate, very thin, flat on both sides; consisting of numerous segments, the earlier ones forming two or three convolutions of a flat spire, the later ones arranged in a broad, straight, linear series. Segmentation distinct; peripheral edge slightly constricted at the sutures; septal lines arched. Aperture simple, terminal."



Figs. 177–179.—Ammobaculites foliaceus. × 40 (after Brady). 177 and 178, side views; 179, specimen mounted in Canada balsam and viewed by transmitted light.

Length $\frac{1}{20}$ inch (1.25 mm.).

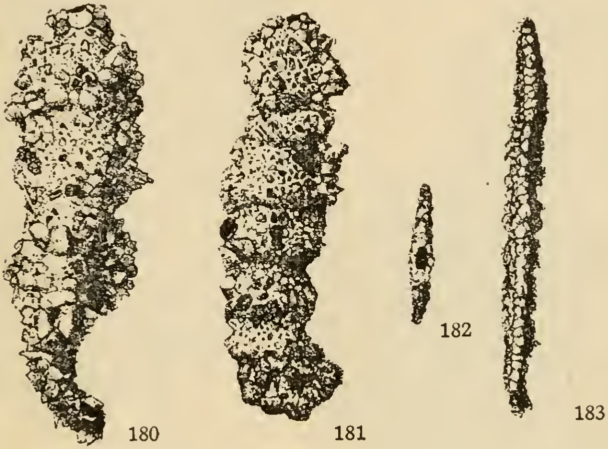
Distribution.—Brady records this species from a single *Challenger* station, No. 232, in 345 fathoms, on the *Hyalonema* ground, south of Japan. The specimens are recorded as "of poor dimensions and few in number."

AMMOBACULITES TENUIMARGO (H. B. Brady).

Haplophragmium tenuimargo H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 303, pl. 33, figs. 13-16.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 275, pl. 19, fig. 3.

Description.—"Test elongate, crosier-shaped, much compressed; lateral edges thin and jagged. Spiral segments few and small; those of the linear series about six in number, broad and slightly convex; septation obscure. Aperture simple, irregular in form; terminal. Texture coarse, surface extremely rough."

Length $\frac{1}{10}$ inch (2.5 mm.) or somewhat less.



FIGS. 180-183.—AMMOBACULITES TENUIMARGO. × 25 (AFTER BRADY). 180, 181, FROM SIDE. 182, APERTURAL VIEW. 183, FROM EDGE, SHOWING THICKNESS OF TEST.

Distribution.—Brady records this species from a single *Challenger* station, No. 238, in 3,950 fathoms, east of Japan. I have seen no specimens referable to this species in the material I have examined from the North Pacific.

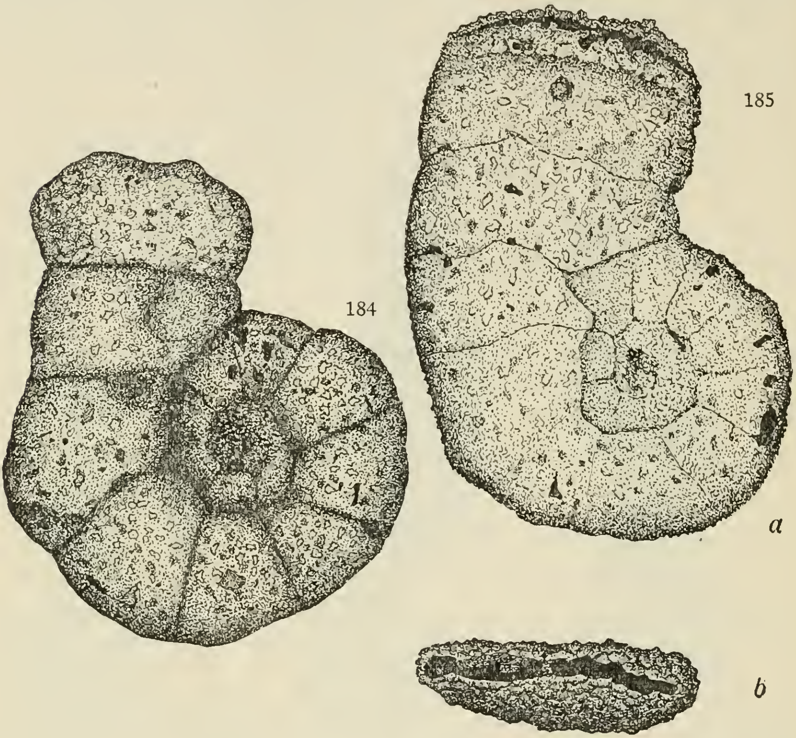
AMMOBACULITES AMERICANUS, new species.

Haplophragmium fontinense H. B. BRADY (not *H. fontinense* TERQUEM), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 305, pl. 34, figs. 1-4.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 31.

Description.—Test planospiral, compressed, slightly or not at all involute, the two sides alike, composed of three or four volutions with about nine chambers in the outer volution, the last formed chambers in fully grown specimens tending to form an uncoiled straight growth, wall made up of sand grains firmly cemented; aperture elongate, oval, or forming a long slit across the apertural face of the chamber; color, gray.

Distribution.—Specimens were found by Goës in material from *Albatross* station D3419 in 772 fathoms, off the west coast of Mexico.

This is a very different species from that described by Terquem from the Oolite of France. The original description of that species refers to a test convex on one side and concave on the other. The recent species is the same on each side and truly planospiral. The aperture varies in the recent specimens, but is usually rather elongate, and the test six times as large as the fossil species described by Terquem.



FIGS. 184–185.—AMMOBACULITES AMERICANUS. 184. × 20. 185 *a*, BROADER, MORE FLATTENED FORM; *b*, APERTURAL VIEW, × 15.

Genus PLACOPSILINA d'Orbigny, 1850.

Placopsilina D'ORBIGNY, Prodr. Pal., vol. 2, 1850, p. 96.—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 315.

Description.—Test attached, chambered, the early portion close-coiled, later portions uncoiling and spreading out in an irregular but in general a linear series of chambers, building no floor; last portion of the test may be entirely free, made up of an irregular series of chambers; wall arenaceous, aperture rounded, at the end of the last formed chamber.

PLACOPSILINA CENOMANA d Orbigny.

Placopsilina cenomana d'Orbigny, Prodr. Pal., vol. 2, 1850, p. 185, no. 758.—Reuss, Denkschr. kais. Akad. Wiss. Wien, vol. 7, 1854, p. 71, pl. 28, figs. 4, 5.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 191, pl. 5, fig. 19.—Haeusler, Quart. Journ. Geol. Soc., vol. 39, 1883, p. 27, pl. 3, fig. 1; Neues Jahrb., vol. 1, 1883, p. 59, pl. 3, figs. 12–14.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 315, pl. 36, figs. 1–3.—Wright, Proc. Belfast Nat. Field Club., 1884–85, App. 9, 1886, p. 320, pl. 26, figs. 3*a*, *b*.—Haeusler, Neues Jahrb., Beil., vol. 4, 1885, p. 8, pl. 1, figs. 24, 25.—Howchin, Journ. Roy. Micr. Soc., 1888, p. 536, pl. 8, fig. 4.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 218, pl. 42, fig. 13.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—Chapman, Proc. Zool. Soc. London, 1895, p. 17.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 4, pl. 1, fig. 7.

Lituola cenomana Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 302.—H. B. Brady, Proc. Somerset Arch. and Nat. Hist. Soc., vol. 13, 1867, p. 105, pl. 1, fig. 1.

Lituola (*Placopsilina*) *cenomana* W. B. Carpenter, Parker, and Jones, Intr. Study Foram., 1862, p. 143, pl. 11, figs. 11–14.

Description.—Test attached, many chambered, the earlier portion close coiled, more or less completely involute, of one or more volutions, later portion uncoiled, forming a linear or irregular series of chambers but building no floor, the body to which it is attached serving as the lower wall, last formed portion in adult specimens or those which are attached to small objects rising free from the attachment and making an irregular cylindrical growth and building a wall on all sides except where it is in contact with the previously formed chamber; wall arenaceous, variable in the finish of its surface, usually rough; aperture fairly large, rounded; color variable, usually gray but occasionally brownish.

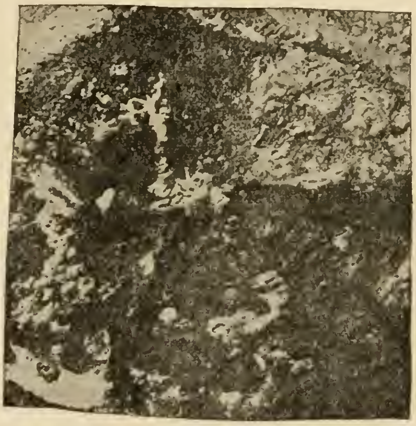


Fig. 186.—Placopsilina cenomana. × 10. From photograph. Specimen attached to stone.

Length in adults up to 5 mm., diameter 0.5–1 mm.

Distribution.—A single specimen was found at *Albatross* station D4900 in 139 fathoms, off Japan.

If one looks up the various figures assigned to this species, a very variable lot of things will be met with. I am not at all certain that the recent material should be assigned to the cretaceous species which d'Orbigny had, for even in recent material many specimens which at a glance would be placed with this species are seen by close study to be rugose species with smooth calcareous tests in the young and belong with the Rotalidæ. If fossilized it would be difficult to distinguish such tests from truly arenaceous ones by superficial examination.

Genus TROCHAMMINA Parker and Jones, 1860.

Nautilus (part) MONTAGU, Test. Brit., Suppl., 1808, p. 81.

Rotalina (part) WILLIAMSON, Recent Foram. infera of Great Britain, 1858, p. 50.

Globigerina (part) WILLIAMSON, Recent Foram. infera of Great Britain, 1858, p. 56.

Trochammina (part) PARKER and JONES, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 337.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 695. Type, *T. inflata* (MONTAGU) = *Nautilus inflatus* MONTAGU.

Lituola (part) PARKER and JONES, Trans. Roy. Soc. London, vol. 155, 1865, p. 407.

Haplophragmium (part) SIDDALL and H. B. BRADY, Cat. Brit. Rec. Foram., 1879, p. 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312.

Ammoglobigerina EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 704.

Description.—Test free or sometimes adherent, spiral, trochoid, chambered; all chambers visible when viewed from above, only the chambers of the last formed volution visible from below; wall arenaceous usually with considerable cement; aperture an arched slit on the ventral side of the chamber at its contact with the preceding volution.

As here considered, *Trochammina* is restricted to those species like *T. inflata* or *T. squamata*, which have a true spiral, trochoid test with all the chambers visible only from above.

TROCHAMMINA SQUAMATA Jones and Parker.

Trochammina squamata JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 1.—PARKER and JONES, Trans. Roy. Soc. London, 1865, p. 407, pl. 15, figs. 30, 31 *a–c*.—H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 288, pl. 11, fig. 4; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 56.—HAEUSLER, Neues Jahrb., 1883, pt. 1, p. 60, pl. 4, fig. 8.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 337, pl. 41, figs. 3 *a–c*.—HAEUSLER, Neues Jahrb., Beil., vol. 4, 1885, p. 29, pl. 3, fig. 30.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 331.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 65, pl. 10, figs. 27–29, 40.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 469.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 264, pl. 5, figs. 4–6.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 695, fig. 43 (in text).—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 362.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 5.

Trochammina proteus KARRER (part), Sitzb. kais. Akad. Wiss. Wien, vol. 52, 1865, p. 494, pl. 1, fig. 6 (not 1–5, 7, 8).

Description.—Test free or sometimes adherent, trochoid spiral, flattened, consisting of three to four volutions with four or five chambers in each, convex above, flattened or somewhat concave below, all chambers visible on the dorsal surface, only those of the last formed volution visible from below; wall composed of sand grains of varying size and a considerable amount of cement, surface fairly smooth; aperture a somewhat arched slit between the wall of the chamber and the adjacent chamber of the previous volution on the lower side of the test; color reddish-brown.

Diameter 0.75–1.25 mm.

Distribution.—There are no previous published records for this species in the North Pacific. It has occurred at three *Albatross* stations, D5095 in 58 fathoms in the Gulf of Tokyo and H4881 in 316 fathoms near Blake Reef, Vincennes Strait, southern Japan. A single large specimen was obtained.

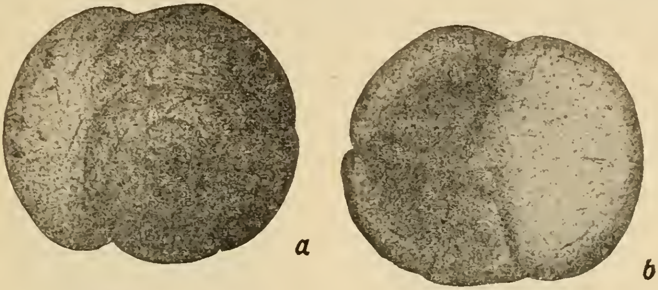


Fig. 187.—Trochammina squamata. × 50 (after Brady). *a*, from above; *b*, from below.

This species is much flatter than the preceding and has fewer chambers in each volution.

TROCHAMMINA INFLATA (Montagu).

Nautilus inflatus Montagu, Test. Brit., Suppl., 1808, p. 81, pl. 18, fig. 3.

Rotalina inflata Williamson, Recent Foraminifera of Great Britain, 1858, p. 50, pl. 4, figs. 93, 94.—Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 4, 1859, p. 347, fig. f.—Williamson, Pop. Sci. Rev., vol. 4, 1865, p. 174, pl. 8, fig. 8.

Trochammina inflata W. B. Carpenter, Parker, and Jones, Intr. Foram., 1862, p. 141, pl. 11, fig. 5.—H. B. Brady, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865, p. 95.—Haeusler, Ann. Mag. Nat. Hist., ser. 5, vol. 10, 1882, p. 351, pl. 15, figs. 5–7; Neues Jahrb., 1883, pl. 1, fig. 60; pl. 4, figs. 6, 7.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 338, pl. 41, figs. 4*a–c*.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1885, p. 331, pl. 13, figs. 11, 12.—Haeusler, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 65, pl. 10, figs. 25, 26.—Woodward and Thomas, Geol. and Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 28, pl. d, fig. 31.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, pl. 5, figs. 10–12, 16–18.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 29, pl. 6, figs. 222–224.—Millett, Journ. Roy. Micr. Soc., 1899, p. 364.—Fornasini, Mem. Real. Accad. Sci. Ist. Bologna, vol. 8, 1900, p. 367, fig. 15.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 6, pl. 1, fig. 9.

Description.—Test trochoid, spiral, composed of about three volutions, the last-formed one consisting of five or six inflated chambers, those of the inner volutions somewhat less inflated, all chambers visible from above, only those of the last-formed volution visible from below, spire low; test umbilicate below; wall composed of fine sand with an excess of cement, smooth, aperture small, a short arched slit where the chamber meets the previous volution on the ventral side and just in from the periphery; color yellowish-brown, the early chambers of the spire often darker than the rest.

Diameter 0.7–1 mm.

Distribution.—There seem to be no published records for the occurrence of this species in the North Pacific. In the material that I have examined it has been seen but once, from *Nero* station 1213, in 808 fathoms, off the coast of Japan.

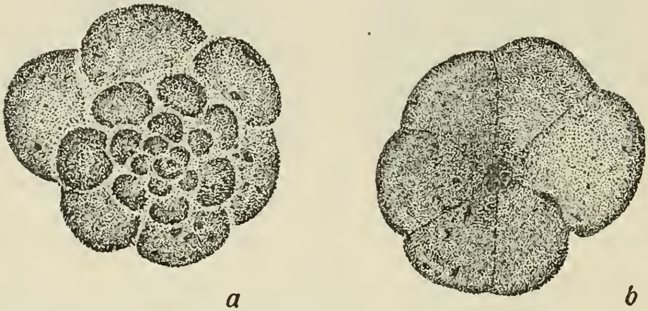


FIG. 188.—TROCHAMMINA INFLATA. × 50. *a*, FROM ABOVE; *b*, FROM BELOW.

TROCHAMMINA TURBINATA (H. B. Brady).

Haplophragmium turbinatum H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312, pl. 35. figs. 9, *a–c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 262, pl. 5, figs. 57–59.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 16.

Trochammina turbinatum EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 695.

Description.—Test spiral, early volutions regular, low spired, last-formed volution in the adult somewhat irregular leaving the regular method of coiling and becoming oblique; five to eight chambers in the last-formed volution, umbilicate below, in adults with a depression above due to the obliquity of the last-formed volution; wall arenaceous, variable in coarseness and amount of cement, aperture a slit at the base of the ventral side of the chamber; color yellowish or reddish brown or grayish.

Diameter 0.75–1.25 mm.

Distribution.—Brady records this species from a single *Challenger* station, 246, in 2,050 fathoms. In the material that I have examined it has occurred at several stations: *Albatross* station D2806, in 1,379 fathoms near the Galapagos Islands; H1521, in 462 fathoms, off the west coast of the United States; D4998, in 66 fathoms, in the Gulf of Tartary off Sakalin Island; and D4979, in 943 fathoms, off Japan. Specimens were found from four *Nero* stations, 1139, 1147, 1184, and 1306, in 1,208–2,101 fathoms, between Yokohama and Guam.

There is a considerable variation in the texture of the specimens included here, but all have the same general characters.

Goës figured and described a variety which he named *Haplophragmium turbinatum*, var. *helicoideum* Goës. Upon looking up the original series labeled by Goës with this name I find among the Pacific material a very much mixed series of tests. In all, there are ten Pacific specimens, none of which at all resembles the figures given by Goës.

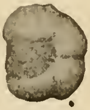


Fig. 189.—Trochammina turbinata. × 35. From photograph.

TROCHAMMINA NANA (H. B. Brady).

Haplophragmium nanum H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Denkschr. kais. Akad. Wiss. Wien, vol. 43, 1881, p. 99, pl. 2, figs. 1, *a–e;* Ann. Mag. Nat. Hist., ser. 5, vol. 8, 1881, p. 406, pl. 21, fig. 1; Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 311, pl. 35, figs. 6–8.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 14, 1888, p. 218, pl. 41. fig. 20.—Chapman, Journ. Roy. Micr. Soc., 1892, p. 324, pl. 5, fig. 15.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 262, pl. 5, figs. 13–15.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 22, pl. 5, figs. 124–127.—Millett, Journ. Roy. Micr. Soc., 1899, p. 360, pl. 5, fig. 9.—Rhumbler, Zool. Jahrb., vol. 24, 1906, p. 65, pl. 5, fig. 56.—Bagg, Proc. U. S. Nat. Mus., vol. 34, p. 127.

Description.—Test trochoid-spiral, spire very low, consisting of two or more volutions, the last-formed one with six to eight chambers, somewhat flattened above but usually rotund below, very slightly or not at all umbilicate, chambers all visible from the dorsal side, only those of the last-formed volution visible from the ventral side; walls composed of sand grains and a large amount of cement, surface fairly smooth; aperture an arched slit at the periphery and ventral edge of the chamber where it is in contact with the adjacent chamber of the preceding volution; color yellowish brown, the last-formed chamber often gray.

Diameter 0.21–0.75 mm.

Distribution.—Brady mentions but one *Challenger* station for this species, 253, in 3,125 fathoms, but in the volume on the "Summary of Results" two other stations are added, 246, in 2,050 fathoms, and 237, in 1,875 fathoms, the last with a question mark. Rhumbler records a single young specimen from Laysan Island. Bagg records it from a single *Albatross* station, H4694, in 865 fathoms, off the Hawaiian Islands. I found several specimens in material from *Nero* station 992, in 1,013 fathoms, off Guam.

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Figs. 190–192.—Trochammina nana. × 35. From photograph.

TROCHAMMINA GLOBIGERINIFORMIS (Parker and Jones).

Globigerina bulloides Williamson, Recent Foraminifera of Great Britain, 1858, p. 56, pl. 5, figs. 116–118 (not *G. bulloides* d'Orbigny 1828).

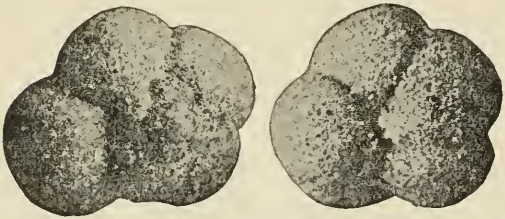
Lituola nautiloidea, var. *globigeriniformis* Parker and Jones, Trans. Roy. Soc. London, vol. 155, 1865, p. 407, pl. 15, figs. 46, 47.

Lituola (*Haplophragmium*) *globigeriniformis* Terrigi, Nuovi Lincei Atti, 1880, p. 175, pl. 1, fig. 3.

Haplophragmium globigeriniforme Siddall, Cat. Brit. Rec. Foram., 1879, p. 4.—W. B. Carpenter, The Microscope, 6th ed., 1881, p. 561, fig. 320 *a*, *b*.—H. B. Brady, Denkschr. kais. Akad. Wiss. Wien., vol. 43, 1881, p. 100; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312, pl. 35, figs. 10, 11.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1885, p. 329.—Haeusler, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 36, pl. 4, figs. 13, 16, 17.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—Terrigi, Mem. Roy. Com. Geol. Italia, vol. 4, 1891, p. 68, pl. 1, fig. 7.—Chapman, Journ. Roy. Micr. Soc., 1892, p. 324, pl. 5, fig. 16.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 260, pl. 5, figs. 30, 31.—Goës. Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 22, pl. 5, figs. 128–133.—Chapman, Proc. Zool. Soc. London, 1895, p. 16.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 30.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 277, pl. 21, fig. 1.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 4, pl. 1, fig. 6.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

Ammoglobigerina bulloides Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 704.

Description.—Test free or adherent, spiral, trochoid, spire varying in its elevation, usually wider than high, chambers globose, all visible from above, only those of the last-formed coil visible from below; test composed of from two to four volutions, the last formed one usually of four, occasionally three, chambers, rapidly increasing in size progressively as added, wall of sand grains and a variable amount of cement, outer surface fairly even; aperture an arched slit on the ventral side of the chamber at its contact with the adjacent chamber of the preceding volution; color of the test reddish-brown.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Figs. 193-194.—Trochammina globigeriniformis. × 20. From photograph. 193, from above; 194, from below.

Diameter 0.5–1.5 mm.

Distribution.—This species is one of the most common of the arenaceous species in deep water. The *Challenger* obtained it at seven stations in the North Pacific in 15–3,950 fathoms, all but one in more than 1,800 fathoms. Goës records it at two *Albatross* stations in the eastern Pacific in 772–1,218 fathoms. Bagg records a few doubtful specimens from the vicinity of the Hawaiian Islands, *Albatross* station H4585 in 689 fathoms. In the present work I have found the species at numerous stations from 392-2,113 fathoms in depth in the *Albatross*, *Nero*, and *Alert* material. At *Albatross* station D3603 it was obtained from Holothurian stomachs at a depth of 1,771 fathoms. It has occurred in largest numbers about Japan.

This species belongs in the genus *Trochammina* as here recognized. It has a regular spirally-formed trochoid test like the other species of *Trochammina* included here and differs only in the very inflated, globular character of the chambers. The elevation of the spire varies somewhat, but as a rule the test is fully as broad as high. In the texture of the wall there is some variation, the amount of cement usually being considerable.

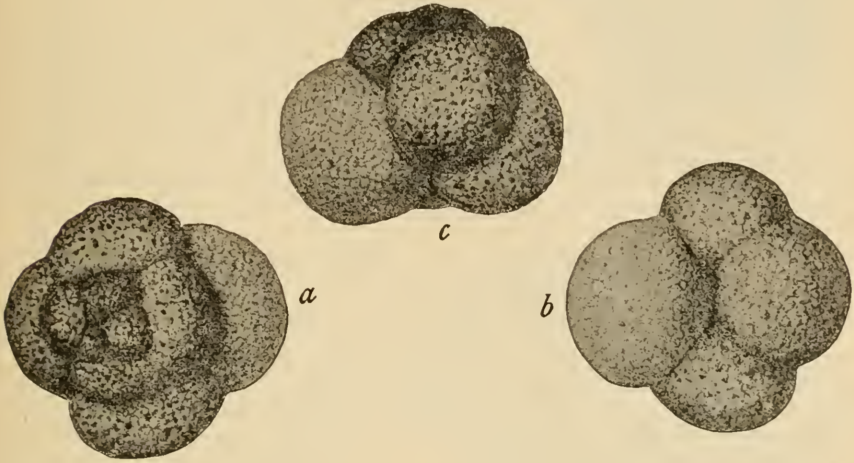


FIG. 195.—TROCHAMMINA GLOBIGERINIFORMIS. × 25 (AFTER BRADY). *a*, FROM ABOVE; *b*, FROM BELOW; *c*, FROM SIDE.

Genus GLOBOTEXTULARIA Eimer and Fickert, 1899.

Haplophragmium (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313.

Globotextularia EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 679.

Description.—Test arenaceous, the early chambers in a spire, the later ones irregular, globular, Globigerina like, containing only the following species:

GLOBOTEXTULARIA ANCEPS H. B. Brady.

Haplophragmium anceps H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313, pl. 35, figs. 12-15.—CHASTER, First Rep. Southport Soc. Nat. Sci., 1890-91 (1892), p. 57, pl. 1, fig. 2.—MILLETT, Proc. Roy. Micr. Soc., 1899, p. 361, pl. 5, fig. 10.

Globotextularia anceps EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 679, fig. 25 (in text).

Description.—Test irregular, early portion spiral with a high spire, compact, later portion with much larger globular chambers, irregular in position, usually four in regular specimens in the outer volution, wall arenaceous, surface fairly smooth; aperture near the inner end of the chamber; color brown.

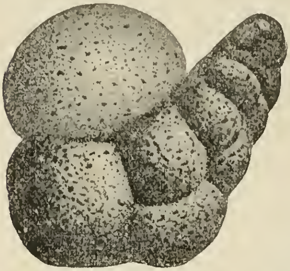


FIG. 196.—GLOBOTEXTULARIA ANCEPS. × 20 (AFTER BRADY).

Diameter 1.5 mm.

Distribution.—Although not recorded by Brady this species is given in the volume on the "Summary of Results" from *Challenger* station 237, 1,875 fathoms off Japan. There is a single specimen from *Albatross* station H2766 in 196 fathoms off California, which I have referred to this species.

Genus AMMOCHILOSTOMA Eimer and Fickert, 1899.

Trochammina (part) H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 58; vol. 21, 1881, p. 52; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 344.

Haplophragmium (part) H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312.

Ammochilostoma (part) EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 692. Type, *A. pauciloculata* (H. B. BRADY)=*Trochammina pauciloculata* H. B. BRADY.

Description.—Test free, early chambers spiral, later ones very involute and the last-formed volution often entirely covering the previously formed chambers and usually at an oblique angle to the earlier growth; wall arenaceous with a variable amount of cement; aperture at or near the base of the apertural face of the chamber, elongate, narrow.

This name was proposed by Eimer and Fickert for three species of *Trochammina*, *T. ringens*, *T. galeata*, and *T. pauciloculata*. As the first of these species has already been included under *Haplophragmoides*, this name, *Ammochilostoma*, will stand for the other two species with others which in their last-formed volution become involute or irregularly winding about the test in a changing plane.

AMMOCHILOSTOMA PAUCILOCULATA (H. B. Brady).

Trochammina pauciloculata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 58, pl. 5, figs. 13-14; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 344, pl. 41, figs. 1, 2.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 265. pl. 5, figs. 37, 38.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 33.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 282, pl. 27, fig. 2.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1907, p. 128.

Ammochilostoma pauciloculata EIMER and FICKERT, Zeitschr. wiss. Zoöl., vol. 65, 1899, p. 692.

Description.—Test ovoid, early chambers spiral, hidden by the later chambers which are in a plane oblique to the early ones and very involute, inflated, three or four chambers visible in an adult specimen; wall arenaceous with an excess of cement, smooth and polished, aperture an elongate slit at the base of the chamber; color yellowish or reddish brown with some of the chambers gray in some specimens.

Diameter 0.14–0.75 mm.

Distribution.—From the *Challenger* work there are four recorded stations in 1,850 to 3,950 fathoms. Goës records the species from a single *Albatross* station, 3375 in 1,201 fathoms, rare. I have examined the material selected by Goës and also that recorded by Bagg from the vicinity of Hawaii in 689–1,398 fathoms, and in both cases the material seems to be typical. The species has occurred at three *Nero* stations, 170 in 1,990 fathoms near Midway Island and at two stations 1155 and 1389 in 1,632 and 1,653 fathoms, between Yokohama and Guam. It has also occurred at three *Albatross* stations, H2898 and H2999, in 1,265 and 549 fathoms near the Hawaiian Islands, and D4979 in 943, fathoms off Japan.

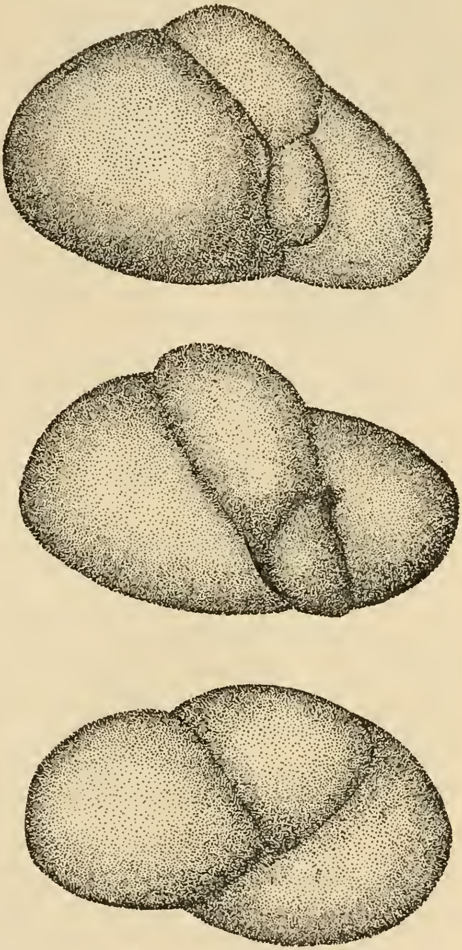


FIG. 197.—AMMOCHILOSTOMA PAUCILOCULATA. THREE VIEWS OF SAME SPECIMEN. × 100.

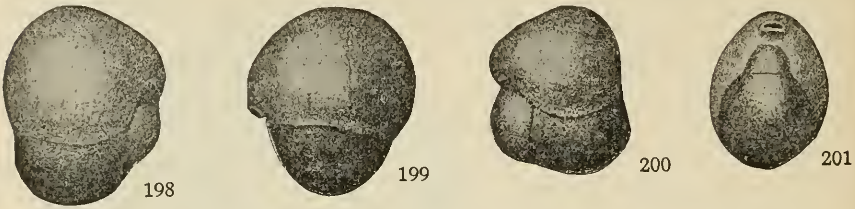
This is a very characteristic species of small size, and with little variation. It usually occurs in but few numbers and most of the stations for the species are in deep water.

AMMOCHILOSTOMA GALEATA (H. B. Brady).

Trochammina galeata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 52 Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 344, pl. 40, figs. 19–23.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 265, pl. 5, figs. 32–43.

Ammochilostoma galeata EIMER and FICKERT, Zeitschr. wiss. Zoöl., vol. 65, 1899, p. 692, fig. 39 (in text).

Description.—Test nearly symmetrical, subglobular, early chambers spiral, the later ones enveloping the earlier ones, the last-formed chamber in the adult forming half the area of the test, wall arenaceous with much cement, smooth; aperture a narrow slit near the base of the apertural face; color yellowish-brown.



FIGS. 198–201.—AMMOCHILOSTOMA GALEATA. × 50 (AFTER BRADY). 201, APERTURAL VIEW.

Diameter 0.5 mm.

Distribution.—There are two *Challenger* records for this species in the North Pacific, 224 in 1,850 fathoms and 237 in 1,875 fathoms, both in the western Pacific.

AMMOSPHÆROIDINA, new genus.

Haplophragmium (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313.—HOWCHIN, Trans. Roy. Soc. South Australia, vol. 12, 1889, p. 6.—CHAPMAN, Journ. Linn. Soc., Zoöl., vol. 30, 1907, p. 24.

Description.—Test globose, arenaceous, early portion spiral, later chambers like *Sphæroidina* in form, embracing; aperture rounded, at one side of the chamber in the adult.

Type of the genus.—*Haplophragmium sphæroidiniformis* H. B. Brady.

This genus in its general external characters much resembles *Spæroidina*, but has a rather coarse arenaceous test.

AMMOSPHÆROIDINA SPHÆROIDINIFORMIS (H. B. Brady).

Haplophragmium sphæroidiniformis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313.—HOWCHIN, Trans. Roy. Soc. South Australia, vol. 12, 1889, p. 6.—CHAPMAN, Journ. Linn. Soc., Zoöl., vol. 30, 1907, p. 24, pl. 3, figs. 50, 51.

Description.—Test free, composed of a spiral earlier portion, the later portion in the adult made up of usually three large globose chambers similar in form and arrangement to *Sphæroidina bulloides*, one large one at one side and two smaller ones at the other, the aperture at the inner side of the last-formed chamber semicircular or rounded; wall rather coarsely arenaceous; color brownish or gray.

Diameter 0.75–1.75 mm.

Distribution.—Specimens referred to this species have been obtained at seven stations in the North Pacific; *Albatross* stations H2986 in 271 fathoms and H3012 in 2,067 fathoms, both near the Hawaiian Islands; and at several *Nero* stations near Midway Island, near Luzon and between Yokohama and Guam in 1,406–2,135 fathoms.

The structural characters of this species will not allow of its being placed in any of the genera used here in a restricted sense and it has seemed best to make a new genus for it.

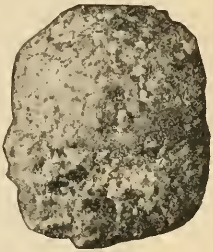


FIG. 202.—AMMOSPHÆROIDINA SPHÆROIDINIFORMIS. × 25. FROM PHOTOGRAPH.

Subfamily 4. NEUSININÆ.

Test arenaceous with some chitin, flattened and broad, composed of many chambers, early portion coiled with the later chambers broad and spreading, sides with elongate chitinous filaments.

This subfamily containing the single species, *Neusina agassizii,* is different from the other arenaceous Foraminifera but in its general plan of structure is not unlike certain other genera.

Genus NEUSINA Goës, 1892.

Neusina GOËS (type, *Neusina agassizii* GOËS), Bull. Mus. Comp. Zoöl., vol. 23, 1892, p. 195.

Description.—Test expanded, flat, made up of a series of very broad, low, flattened chambers, early ones in complete specimens apparently coiled, later ones in a broad, flat expanse of varying shape; wall arenaceous or of fine mud and sand with a chitinous network, flexible with a thread-like border of chitin; apertures numerous, along the edge of the chamber; color in fresh specimens brown.

NEUSINA AGASSIZII Goës.

Neusina agassizii GOËS, Bull. Mus. Comp. Zoöl., vol. 23, 1892, p. 195, pl., figs. 1–9.

Description.—Similar to that of the genus, simply the one species being known.

Diameter in largest specimen, 190 mm.

Distribution.—Specimens of this species were found in material from a single *Albatross* station, D3399, off the northwest coast of South America in 1,740 fathoms in olive green ooze.

There has been much discussion as to whether this is really a foraminifer or not. It has many of the characters of the group and the main objection to placing it here is on account of its size. A single small specimen in the National Museum figured here shows something of the early development. Evidently from this specimen there is a close coiled young, then an arcuate uncoiled growth, and finally the broad, flaring growth characteristic of the adult is taken on. The specimen was associated with *Rhizammina algæformis* H. B. Brady.

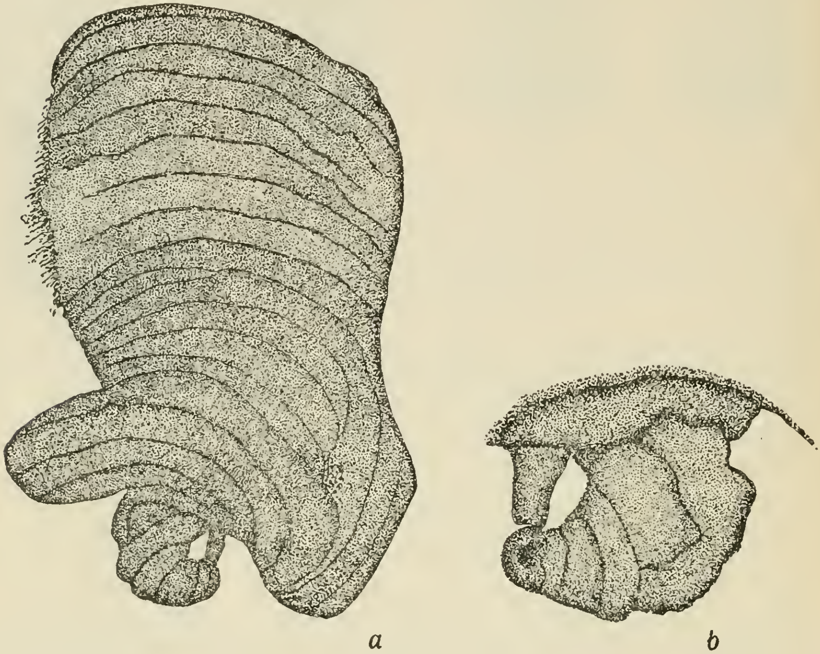


FIG. 203.—NEUSINA AGASSIZII. *a*, COMPLETE SPECIMEN, × 1½. *b*, EARLY PORTION OF SAME SPECIMEN FROM OPPOSITE SIDE, × 5.

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Part II. TEXTULARIIDÆ

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JOSEPH AUGUSTINE CUSHMAN
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INTRODUCTION.

The present volume is the second of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the family Textulariidæ. The first part, issued in 1910, included the families Astrorhizidæ and Lituolidæ. The third part, on which work is now actively being done, will be devoted to the Lagenidæ, and further volumes will take up the remaining families of the Foraminifera as they are represented in the North Pacific.

Joseph Augustine Cushman.

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

TEXTULARIIDÆ.

By Joseph Augustine Cushman.
Of the Boston Society of Natural History.

INTRODUCTION.

This second part of the work on the North Pacific Foraminifera deals entirely with the Textulariidæ, a family following in natural sequence those families already considered in the first part. The same arrangement of data is here followed.

In addition to the material mentioned in the previous part there has been available a considerable amount dredged by U. S. S. *Tuscarora* in various parts of the North Pacific. This consists of mounted slides of Foraminifera from the various stations. It adds some species and a considerable number of records of distribution for many species.

It has been found necessary to describe several new species and to erect a few new genera, but the number of these has been kept as small as possible. The genus *Textularia*, as will be noted, contains several more or less distinct groups of species, but no attempt is here made to give these groups generic standing. The species of certain genera, such as *Bulimina* for example, are in an unsatisfactory state, and without large series of specimens it is impossible to satisfactorily delimit the various species. Figures referred to the same species by different authors are often very unlike and the synonymy thus becomes very difficult to work out satisfactorily.

Reference to the figures and descriptions of types has shown the necessity of separating our recent forms from the fossil species in a number of cases. Where this is necessary and no names are available, new names have of necessity been given to the recent species.

More strikingly perhaps than in the first part the various faunal areas are shown by the species of the Textulariidæ. Many of the species occurring in the Indo-Pacific region extend southward to the region of Torres Strait. In the North Pacific, however, these species are, as a rule, confined to the western portion from southern Japan southward. The rediscovery of some of the species described by Brady, from almost the exact locality at which they were dredged by the *Challenger*, is very interesting and tends to show the restricted distribution of certain forms.

A systematic presentation of the various groups of the family follows:

Family 4. TEXTULARIIDÆ.

Test either arenaceous or calcareous, perforate, the chambers usually numerous, essentially biserial or triserial, or in some genera spirally arranged.

The family Textulariidæ is apparently the most primitive, after the Lituolidæ. A number of the genera are wholly or in part composed of species with arenaceous tests, which is in itself a primitive character in the group. In many species both the microspheric and megalospheric forms are known. In the microspheric form, which repeats most completely the phylogenetic characters, a coiled early development succeeding the proloculum is commonly found. This stage may be compared to the entire development of such a genus as *Haplophragmoides* in the Lituolidæ.

In the most primitive subfamily, the Spiroplectinæ, the coiled development is continued for a fairly long period, and makes up a considerable portion of the test. This coiled stage also occurs in both the microspheric and megalospheric forms, showing that this subfamily is decidedly primitive, and has not as yet become so specialized as to lose the coiled stage in the megalospheric form. In *Spiroplecta*, the only genus of this subfamily, the coiled development is followed by a series of more or less numerous chambers arranged biserially. *Spiroplecta* in its stages of development recapitulates the essential features of the Textulariidæ; a proloculum, followed by a closely coiled series of chambers, in turn followed by a biserially arranged group. This sequence is the basis of the development throughout the family, as will be shown, and is not an exceptional character.

In the Textulariinæ, the typical genus of which, *Textularia*, may be taken as an example, the same stages are shown, but are modified by specialization and acceleration of development. The earlier stages are either much reduced or are entirely skipped. In the case of *Textularia candeiana* d'Orbigny, for example (figs. 14–17), in the microspheric form the small proloculum is followed by a series of chambers, few in number compared with those of *Spiroplecta*, but just as distinctly coiled (fig. 16). The later chambers, which in this case make up the greater part of the test, are biserially arranged. The stages in the development are exactly the same, but there is a difference in the proportion of each as usually occurs in the upward step in the scale, the earlier stages being shortened and the later stages coincidently shoved back and taking their place. In the megalospheric form of the species, however (fig. 17), there is a larger proloculum, followed at once by the biserially arranged chambers, the coiled stage being entirely skipped. Microspheric forms of such species of *Textularia* have been referred by many later writers to *Spiroplecta*, but in the type species of *Textularia* both of these forms occur, and if such a procedure were adhered to, the genus *Textularia* would have to be made synonymous with *Spiroplecta* and the former used as the older name, the latter being dropped. As used here, however, *Spiroplecta* includes simply those species which have a very considerable coiled stage, and in which it usually occurs in both forms, microspheric and megalospheric.

In *Textularia*, it is only very rarely, so far as observed, that a coiled stage occurs in the megalospheric form, and then in but a very few chambers. It is obvious, therefore, that the microspheric form of many species of *Textularia* has a coiled development in the young. In the more specialized species, such as *Textularia quadrilatera*, which should perhaps be removed from the genus *Textularia*, there has been observed no coiled young in either the microspheric or the megalospheric form, though the number of available specimens of each form has been large.

In this same subfamily have been included those other genera which have essentially a biserial arrangement of the chambers, such as *Bolivina* and *Pavonina*, and a biserial development followed by a uniserial, as in *Bigenerina*. In this last genus there is a coiled development in the microspheric form of at least one species.

In the subfamily Verneuilininæ, the typical arrangement of the adult chambers is triserial instead of biserial, but here again there is in the microspheric form of some species a coiled series of chambers in the young. The specimens are much more difficult to manipulate, and the coiled series may be more common than may at first appear. The expected modification, the return to the biserial condition of the previous subfamily, takes place in *Gaudryina*, in some species only in the last-formed chambers, in other species appearing by acceleration of development early in the life history, the triserial portion much reduced. In *Clavulina* there is a complete return to the uniserial condition, but with the triserial character present in the young.

The subfamily Buliminінæ, as here considered, includes the spiral forms with a loop-shaped aperture, such as *Bulimina* and *Virgulina*, the latter tending to assume a biserial arrangement. The test here is hyaline and perforate. Two new genera have been separated from the typical *Bulimina* to include species considerably different in their characters from the genus in its restricted sense.

The subfamily Cassidulininæ includes species which are like the Buliminidæ in their aperture, but which have a peculiar arrangement of the chambers. These are biserial, but are secondarily coiled in a helicoid spiral. In *Cassidulina* the species are either completely involute, or in late growth are somewhat uncoiled. In *Ehrenbergina* the uncoiling takes place early, and little of the involute character is seen.

The Textulariidæ as a whole are much more rich in ornamentation and complicated forms than are any of the preceding families. In *Bolivina* and in some species of *Bulimina, Ehrenbergina,* and *Virgulina* there is a considerable range of ornamentation, punctæ, limbate sutures, knobs or bosses, costæ and spines being the most common forms. On the whole, however, the ornamentation is simple and uninteresting compared with that seen in the Lagenidæ.

Subfamily 1. SPIROPLECTINÆ.

Test either coarsely arenaceous or calcareous, or even hyaline, the early chambers following the proloculum closely coiled, the later chambers biserial, occasionally tending to become uniserial in the last developed chambers.

This subfamily includes the single genus *Spiroplecta,* which in its developmental stages connects the Textulariidæ with the Lituolidæ. Its development is primitive in that the stages are seen in both the microspheric and megalospheric forms of the species, and are of comparatively long duration.

Genus SPIROPLECTA Ehrenberg, 1844.

Spiroplecta Ehrenberg (type, *S. americana* Ehrenberg), Monatsber. d. k. preuss. Akad. Wiss., Berlin, 1844, p. 75.

The characters are given above under the description of the subfamily. The name *Heterohelix* was used by Ehrenberg in 1843, but it is not clear whether it is entirely synonymous or not, and the type-species is not clearly characterized.

As noted above, many recent writers are referring to *Spiroplecta* species of *Textularia* which show a coiled arrangement of the chambers in the early development, especially in the microspheric form. Such a treatment of these species seems to be incorrect, as previously stated. Although Brady records two species of this genus from Torres Strait, neither of them has been found in the material from the North Pacific which I have examined.

SPIROPLECTA BULBOSA, new species.

Description.—Test compressed, the early portion nearly circular, the later portion elongate, narrower, rectilinear; the chambers numerous, those of the early portion coiled, involute, the later biserial; wall calcareous, perforate, smooth; color white.

Length about 0.40 mm.

Type-specimen.—Cat. No. 8328, U.S.N.M., from *Albatross* station D4957 in 437 fathoms off the coast of Japan.

This species is small, and has a remarkably large portion of the test made up by the spirally coiled chambers. Fig. 1, *b*, shows the arrangement of the chambers in the megalospheric form, making a complete volution about the proloculum.

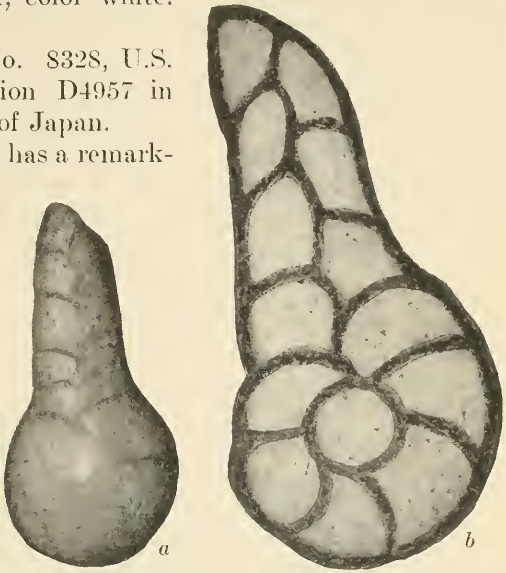


Fig. 1.—Spiroplecta bulbosa. *a*, view from exterior, showing large proportion of the circular part of the test. × 120. *b*, optical section of the test, showing the complete volution made by the coiled chambers about the proloculum. × 200.

Subfamily 2. TEXTULARIINÆ.

Test typically biserial, wholly or in part, the early portion in the microspheric form often with a few coiled chambers, followed by the biserial chambers; later chambers variously modified in the different genera, uniserial, broadly extended, etc.; wall either arenaceous or calcareous and hyaline, perforate; aperture single, or in a few cases, many present in a single chamber.

This subfamily includes those forms which are essentially biserial in their development, not having reached the triserial stage anywhere in their stages of development. The stages in the simpler genera are like those of *Spiroplecta*, except in duration, the biserial condition being taken on much earlier than in that genus. Variously modified forms occur as in the uniserial arrangement in *Bigenerina*, the broadly flaring later growth of *Pavonina*, and the peculiarly modified aperture in *Pleurostomella*.

Genus TEXTULARIA DeFrance, 1824.

Textularia DeFrance (type, *T. sagittula* DeFrance) Dict. des Sci. Nat., vol. 32, 1824, p. 177; vol. 53, 1828, p. 344; Atlas Conch., pl. 13, fig. 5.

Textilaria Ehrenberg, Abh. d. k. preuss. Akad. Wiss., Berlin, 1839, p. 135.

Grammostomum Ehrenberg (part), Abh. d. k. preuss. Akad. Wiss., Berlin, 1839, p. 129.

Plecanium Reuss, Sitz. kön. Akad. Wiss., Wien, vol. 44, 1861 (1862), p. 383.

Description.—Test elongate, tapering, composed of two series of alternating chambers; wall calcareous, in the young, hyaline and perforate, occasionally so throughout the test, often with an external coating of siliceous or calcareous sand, or in some species nearly the whole test arenaceous; aperture typically an arched slit at the inner margin of the chamber close to its line of attachment to the preceding chamber; occasionally with the aperture surrounded by a raised lip, or in some species with the aperture circular and terminal.

The genus *Textularia* as usually considered includes species of several different sorts which might perhaps be placed in separate genera, as has been done by some authors. All have the same general type of test in that the chambers, at least in the adult, are arranged biserially, each chamber alternating with the immediately preceding and succeeding chamber of the opposite side and connecting with them, so that typically no chambers of the same series are connected with one another except indirectly through the chambers of the opposite series. In many species where a large series of specimens can be obtained from a single dredging both the microspheric and megalospheric forms of the species may be found. Here again there is a considerable difference in the various groups. In the typical arenaceous species the microspheric form has a definitely coiled series of chambers about the small proloculum before the biserial condition is taken on. This shows its relation to *Spiroplecta* and to the coiled forms of the Lituolidæ. In the megalospheric form of the same species the biserial condition is usually taken on by the two chambers immediately succeeding the large proloculum. As a rule the megalospheric form is the more common, as is usually the case in other groups.

Other species, as *T. quadrilatera*, for example, may be found in the two forms, but the difference is mainly in the size of the proloculum and the number of succeeding chambers, in both cases the biserial condition being taken on with the two chambers following the proloculum.

Usually in species of *Textularia* there is a regular increase in the diameter of the test with the addition of new chambers, but in some individuals there is a definite senescence, in which the chambers of the later portion are smaller and the diameter of the test actually reduced.

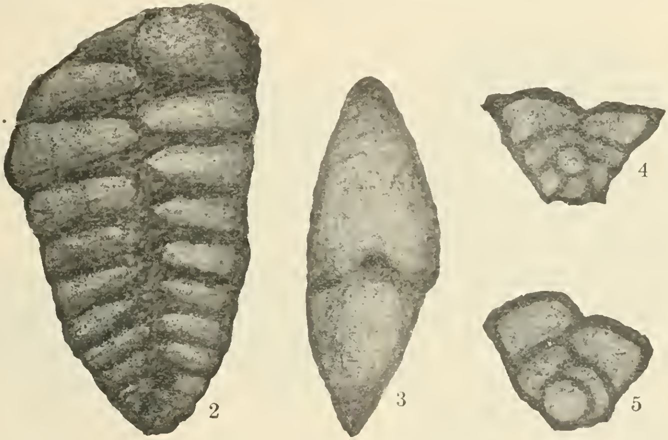
In an end view it is usually seen that the lateral portions of the newly added chamber extend beyond the aperture on either side so that the aperture in the end view seems to be in an indentation of the inner margin of the chamber. This is especially true of those species that have the aperture a slitlike opening on the inner margin close to the line of meeting with the previous chamber. In those species in which the aperture is not so elongate and is farther from the previous chamber, this indentation is much less marked or wanting, and where the aperture is circular and terminal there is no trace of an indentation.

As a whole the genus *Textularia* shows little trace of ornamentation of the test, except in the thickening of the wall at the junction of the chambers and occasionally spines at the earlier end. In a few species there are signs of raised lines of ornamentation. In one group of species there is a tendency to form proliferations at the sides of the chambers, carried to its extreme in *T. siphonifera* H. B. Brady. These are peculiar modifications of the test and occur in several species.

The largest and best-developed species of *Textularia* are from shallow water in tropical or subtropical seas, but the various species are widely distributed, both as to depth and latitude, and the geological history of the genus is apparently a long one.

TEXTULARIA SAGITTULA DeFrance, var. ATRATA, new variety.

Description.—Test as a rule broader than in the typical form, the initial end broad and rounded in both the microspheric and megalospheric forms; sutures between the chambers covered by a dark material much darker than the rest of the test; test otherwise unornamented.



FIGS. 2-5.—TEXTULARIA SAGITTULA, VAR. ATRATA. 2, FRONT VIEW. × 60. 3, END VIEW OF ANOTHER SPECIMEN. × 60. 4, VIEW OF MICROSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS BY TRANSMITTED LIGHT, THE EARLY CHAMBERS FORMING A COILED SERIES ABOUT THE PROLOCULUM, THE LATER CHAMBERS ASSUMING THE BISERIAL CONDITION. × 75. 5, VIEW OF MEGALOSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS BY TRANSMITTED LIGHT, THE EARLY CHAMBERS FOLLOWING THE PROLOCULUM IMMEDIATELY ASSUMING THE BISERIAL CONDITION. × 75.

Length 1 mm., microspheric proloculum 0.04 mm., megalospheric proloculum 0.07 mm.

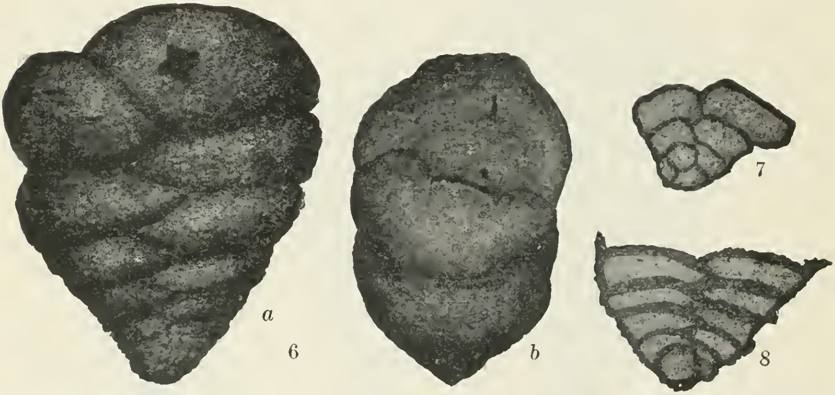
Distribution.—This variety occurred in some numbers at *Albatross* station D4875, in the eastern channel of the Korean Straits, in 59 fathoms. (Type, Cat. No. 8329, U.S.N.M.)

The peculiar dark condition of the material above the sutures was noted in all the specimens from this region.

TEXTULARIA GRAMEN d'Orbigny.

Textularia gramen D'ORBIGNY, For. Foss. Vienne, 1846, p. 248, pl. 15, figs. 4, 6.—H. B. BRADY, Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 365, pl. 43, figs. 9, 10.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 332, pl. 13, figs. 13, 14.—FORNASINI, Boll. Soc. Geol. Ital., vol. 6, 1887, p. 399, pl. 11, figs. 4*a*, *b*.—TERRIGI, Mem. R. Acc. Lincei, ser. 4, vol. 6, 1889, p. 109, pl. 5, figs. 1, 2.—HÆSLER, Abh. Schweiz. Pal. Ges., vol. 17, 1890, p. 71, pl. 11, figs. 26, 27, 37.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 470.—FORNASINI, For. Plioc. Pont. Savena, 1891, pl. 2, fig. 6.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 272, pl. 6, figs. 24–26.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 19.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 284, pl. 29, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 563.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 7.—CHAPMAN, Journ. Linn. Soc. (Zool.), vol. 30, 1907, p. 25, pl. 3, fig. 53.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 30.

Description.—Test rather short and broad, thick, subconical, increasing rapidly in diameter; chambers broad and low, the lateral borders acutely angled, the early chambers compressed, the sutures often indistinct; wall arenaceous, sometimes rough; aperture elongate, slitlike, in the indentation near the base of the inner border of the chamber.



FIGS. 6–8.—TEXTULARIA GRAMEN. 6, *a*, SIDE VIEW; *b*, END VIEW. × 60. 7, MICROSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS VIEWED BY TRANSMITTED LIGHT, THE EARLY CHAMBERS FORMING A COILED GROUP HALFWAY AROUND THE PROLOCULUM. × 150. 8, MEGALOSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS, THE CHAMBERS FOLLOWING THE PROLOCULUM ASSUMING THE BISERIAL FORM AT ONCE WITHOUT TRACE OF COILING. SPECIMEN VIEWED BY TRANSMITTED LIGHT. × 75.

Length 1 to 1.5 mm., microspheric proloculum 0.014 mm., megalospheric proloculum 0.05 mm.

Distribution.—This species is widely distributed. It is recorded by Bagg from seven *Albatross* stations in the vicinity of the Hawaiian Islands, in from 275–865 fathoms. From the Western Pacific I have seen specimens from Hongkong and from Gaspar Strait. One from the latter locality occurring with the typical form is shown in fig. 9, where the irregularity of the last-formed chambers gives a very different appearance to the test. Both microspheric and megalospheric specimens were found in the material from Gaspar Strait, figs. 7 and 8. In the specimen of the microspheric form but few chambers were included in the early coiled portion. The megalospheric form was, as usual, much the more common of the two.

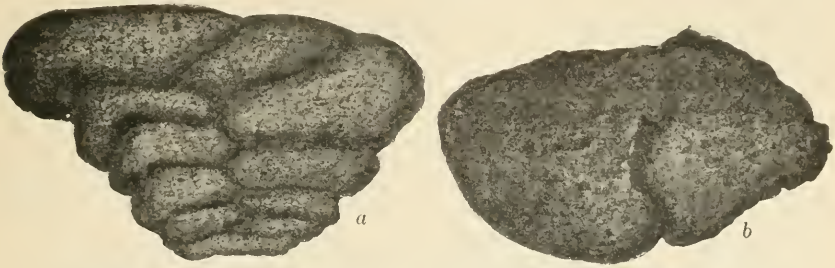


Fig. 9.—TEXTULARIA GRAMEN. *a*, SIDE VIEW, SHOWING THE PECULIARLY MODIFIED CHAMBERS IN THE LATER GROWTH; *b*, END VIEW. × 60.

TEXTULARIA AGGLUTINANS d'Orbigny.

Textularia agglutinans d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 136, pl. 1, figs. 17, 18, 32–34.—Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 369.—Mœbius, Beitr. Meeresfauna d. Insel Mauritius, 1880, p. 93, pl. 9, figs. 1–8.—H. B Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 363, pl. 43, figs. 1, 2.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 267, pl. 6, figs. 1, 2.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 1, 1894, p. 35, pl. 7, figs. 300, 301; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 41.—Millett, Journ. Roy. Micr. Soc., 1899, p. 562.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 7.

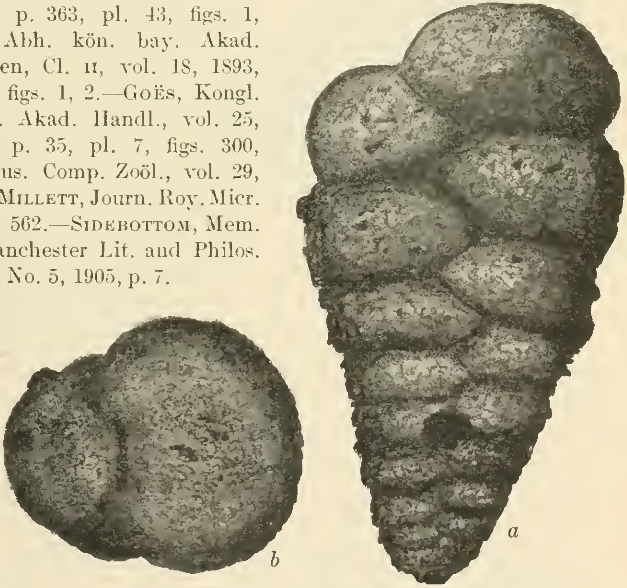


Fig. 10.—Textularia agglutinans. × 40. *a*, FRONT VIEW; *b*, END VIEW.

Description.—Test large and stout, somewhat elongate, the chambers high, rotund; wall coarsely arenaceous in surface view, with a calcareous base as seen in section, the early chambers somewhat compressed, in end view somewhat rounded; aperture in a well-marked depression of the inner border of the chamber, slitlike; surface roughened; last-formed chamber often more smooth.

Length 1–3 mm.

Distribution.—The species seems to have a wide range both in depth and latitude. Brady records it from *Challenger* station 253, in 3,125 fathoms, in the North Pacific. It is more often found in rather shallow water. Bagg records it from four *Albatross* stations near the Hawaiian Islands, in from 104–1,342 fathoms. The most typical specimens are from *Nero* station 2071, in 271 fathoms, off the Hawaiian Islands.

The various figures of specimens assigned to this species show the great variety of forms which have been grouped under this specific name.

TEXTULARIA AGGLUTINANS d'Orbigny, var. FISTULA, new variety.

Description.—In general similar to the typical form, but with lateral fistulose projections on the early chambers, these in the later chambers becoming extended into a projecting peripheral border; the early chambers are somewhat compressed, the later rotund as in typical *T. agglutinans*.

Length 1–2 mm.

Distribution.—Numerous specimens of this variety were found in material from *Albatross* station H3007, in 323 fathoms, and *Nero* station 2071 (type), in 271 fathoms, both near the Hawaiian Islands; also from Blake Reef, Vincennes Strait, off southern Japan, in 248 fathoms. (Type, Cat. No. 8330, U.S.N.M.)

The specimens occur with the typical form, and are apparently a fistulose variety of it. In the form and appearance of the extended rim on the later chamber it is very different from *T. sagittula*, var. *fistulosa* H. B. Brady, which it otherwise in some ways resembles.

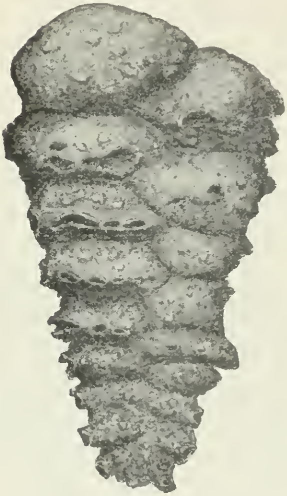


Fig. 11.—Textularia agglutinans, var. fistula. × 40.

TEXTULARIA HORRIDA Egger.

Textularia horrida Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 270, pl. 6, figs. 11, 12 [*T. horroida* on explanation of plate].

Description.—Test broad, short, compressed, composed of a few low chambers directed backward, each extending outward into an elongated process; walls rough, made up of cemented particles of calcareous sand; aperture a curved slit in an indentation of the inner margin of the chamber.

Length 0.37–0.80 mm.

Distribution.—Egger's specimens were from Mauritius. The specimen figured here is from the Hawaiian Islands, *Nero* station 2071, in 271 fathoms.

The semilunar form of the last-formed chambers, the backward direction of the outer portions of the chambers and their prolongations serve to distinguish the species.

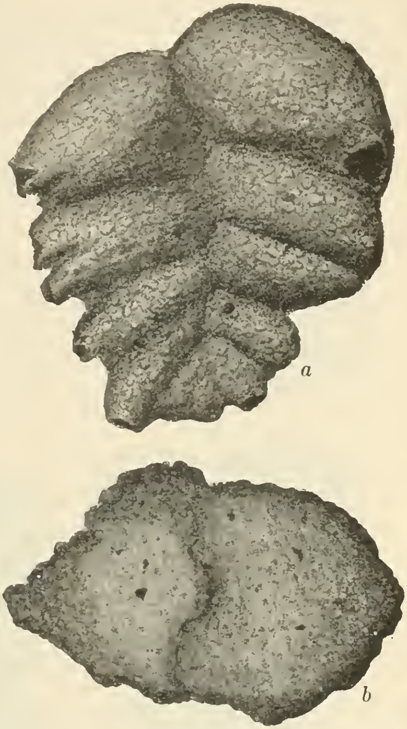


FIG. 12.—TEXTULARIA HORRIDA. × 60. *a*, FRONT VIEW; *b*, END VIEW.

TEXTULARIA STRICTA, new species.

Description.—Test long and narrow, composed of numerous high chambers, the early portion somewhat compressed, the later portions nearly circular in cross section, the later chambers inflated, giving a lobular outline to the test; wall arenaceous but rather smoothly finished; sutures deep; apertural end somewhat acute; aperture an elongated slit near the base of the inner border of the chamber.

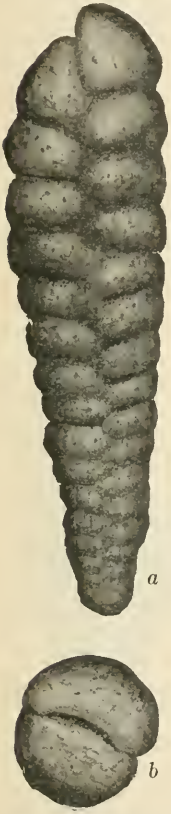


FIG. 13.—TEXTULARIA STRICTA. × 15. *a*, FRONT VIEW; *b*, END VIEW.

Length up to 6 mm.

Distribution.—Specimens of this species were very common in material from *Albatross* station D4900 in the Eastern Sea off southwestern Japan, in 139 fathoms. (Type, Cat. No. 8331, U.S.N.M.)

This is one of the largest species of *Textularia* I have met with, and seems to differ from the other described species in form and size, and in the form of its apertural end. Some of the specimens had 40 or more chambers.

TEXTULARIA CANDEIANA d'Orbigny.

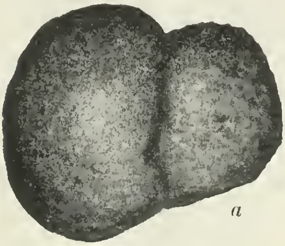
Textularia candeiana D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 143, pl. 1, figs. 25–27.—FORNASINI, Mem. Accad. Sci. Bologna, ser. 5, vol. 10, 1902–1904, p. 137, pl., fig. 8.

Textularia sagittula, var. *candeiana* MILLETT, Journ. Roy. Micr. Soc., 1899, p. 562, pl. 7, fig. 12.

Description.—Test elongate, club-shaped, the early portion narrow, much compressed, the edges almost carinate, slightly tapering to the round-pointed apex, the later chambers enlarging rapidly, much inflated; chambers numerous; wall rather coarsely arenaceous; aperture in a broad but shallow sinus at the base of the inner margin of the chamber; color dark gray.

Length about 1 mm.; microspheric proloculum about 0.015 mm. megalospheric proloculum about 0.050 mm.

Distribution.—There are no previously recorded stations for this species in the North Pacific. Fornasini refers *Textularia polita* Schwager, var. *inflata* Goës to this species. If such were really the relationship of this form, Goës's specimens would provide records for this area, but an examination of Goës's material shows it to be very different.



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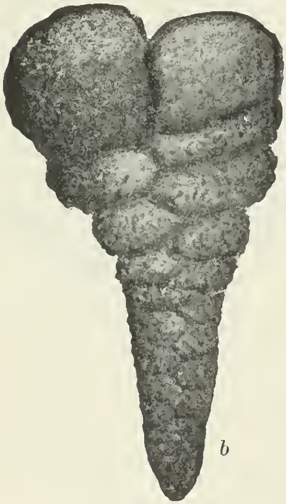

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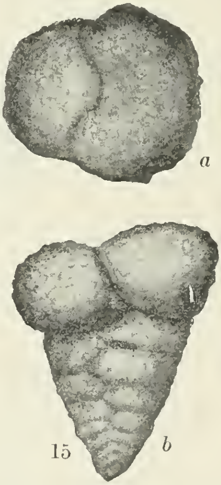

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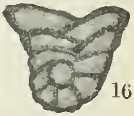

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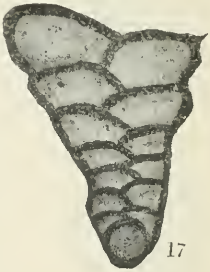


FIGS. 14–17.—TEXTULARIA CANDEIANA. 14, SPECIMEN FROM HAWAIIAN ISLANDS. × 60. *a*, APERTURAL VIEW; *b*, FRONT VIEW. 15, SPECIMEN FROM GASPAR STRAIT. × 60. *a*, APERTURAL VIEW; *b*, FRONT VIEW. 16, MICROSPHERIC PROLOCULUM AND EARLY COILED CHAMBERS. × 115. 17, MEGALOSPHERIC PROLOCULUM AND FOLLOWING CHAMBERS OF MEGALOSPHERIC FORM. × 115.

The species was found to be abundant in the region of the Hawaiian Islands in comparatively shallow water, at *Nero* stations 2042 and 2043, in 55 and 58 fathoms. Specimens, less elongate, were also found in material from Gaspar Strait (fig. 15).

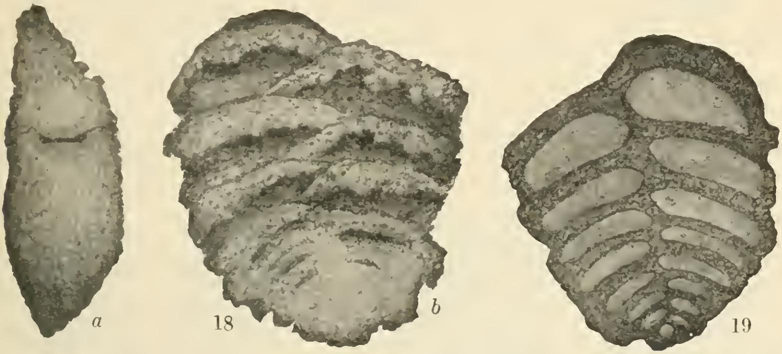
Some of the Hawaiian specimens are very much expanded at the apertural end, even more so than the figured specimen. This is especially accentuated when they are viewed laterally so that the thin edge of the early portion is seen.

Both megalospheric and microspheric forms were found in the material examined. In the microspheric form the early portion is coiled as in this form in other species. The coiling is not apparent in the megalospheric form.

TEXTULARIA MILLETTI, new species.

Textularia sagittula, var. *jugosa* MILLETT, Journ. Roy. Micr. Soc., 1899, p. 561, pl. 7. fig. 8.

Description.—Test free, compressed, composed of numerous broad, low chambers, rapidly increasing in breadth in the earlier chambers, in end view narrow, acutely pointed at the lateral margins; wall coarsely arenaceous; distal and inner walls of chambers much thickened, forming a raised ridge, often with irregular portions extending from the proximal edge; peripheral margin thin; chambers of earlier portions often obscure in external view.



FIGS. 18–19.—TEXTULARIA MILLETTI. 18, *a*, END VIEW; *b*, FRONT VIEW. × 50. 19, OPTICAL SECTION BY TRANSMITTED LIGHT. × 40.

Length 1 mm., megalospheric proloculum 0.055 mm. (in one specimen).

Distribution.—Specimens referred to this species were obtained at four North Pacific stations, *Nero* stations 990 (type), in 859 fathoms, and 1464, in 891 fathoms, both near Guam; also *Nero* station 1205, in 737 fathoms, south of Yokohama, and *Albatross* station H3007, in 323 fathoms, near the Hawaiian Islands.

Type.—Cat. No. 8332, U.S.N.M. Apparently the recent form figured by Millett from the Malay Archipelago is the same species.

The form and ornamentation of the test will distinguish this species from others of the genus.

TEXTULARIA ABBREVIATA d'Orbigny.

Textularia abbreviata D'ORBIGNY, For. Foss. Vienne, 1846, p. 249, pl. 15, figs. 9-12 (7-12).—EGGER, Neues Jahrb., 1857, p. 293, pl. 12, figs. 17, 18.—FORNASINI, Boll. Soc. Geol. Ital., vol. 6, 1887, p. 399, pl. 11, figs. 1*a*, *b*, 3*a*, *b*.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 42, figs. 4, 5.—TERRIZI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 109, pl. 5, fig. 3.—FORNASINI, Mem. Accad. Sci. Bologna, ser. 5, vol. 10, 1902-1904, p. 139, pl., fig. 10.

Description.—Test short and broad, somewhat compressed, the apical end bluntly and the apertural end broadly rounded; chambers few, broad and low; sutures indistinct; wall arenaceous, fairly smooth; aperture at the inner border of the chamber rather narrow and deep; color gray.

Length about 0.50 mm., breadth 0.65 mm.

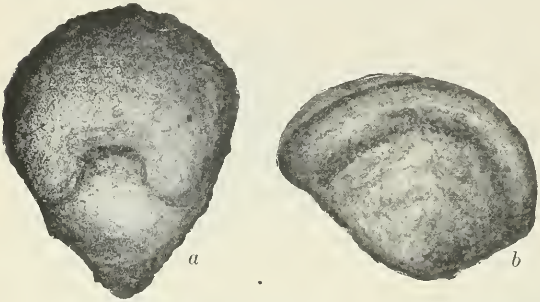
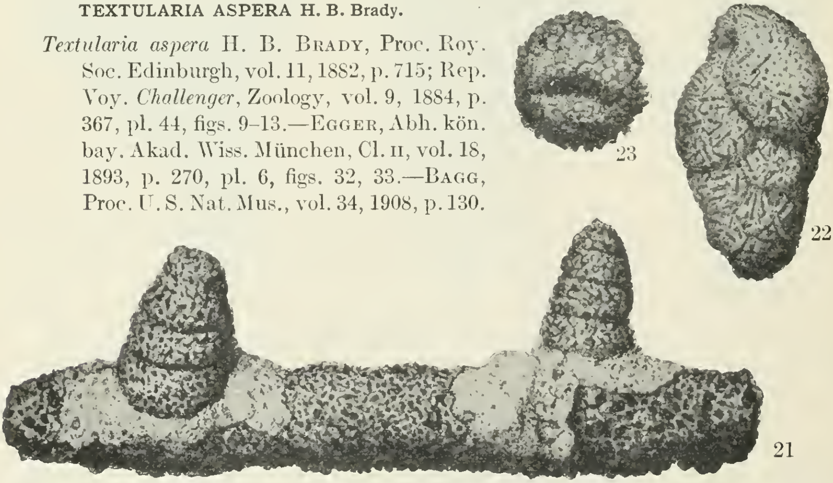


FIG. 20.—TEXTULARIA ABBREVIATA. × 60. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

Distribution.—Apparently not previously recorded from the North Pacific. The figured specimen is from the coast of Japan, *Albatross* station D4968, in 253 fathoms.

TEXTULARIA ASPERA H. B. Brady.

Textularia aspera H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 367, pl. 44, figs. 9-13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 270, pl. 6, figs. 32, 33.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 130.



FIGS. 21-23.—TEXTULARIA ASPERA. 21, SPECIMENS GROWING ATTACHED TO A FRAGMENT OF RHABDAMMINA. × 20. 22, FRONT VIEW OF SPECIMEN DETACHED. × 25. 23, END VIEW OF ANOTHER SPECIMEN. × 25. (AFTER BRADY.)

Description.—Test free or adherent, rather broad, slightly tapering, somewhat compressed, in end view broadly rounded, composed of few chambers, which are inflated, with distinctly depressed sutures; chambers high; wall coarsely arenaceous, somewhat roughened; aperture a subelliptical opening at the base of the inner margin of the chamber.

Length 1.26–2.25 mm.

Distribution.—The only North Pacific record for this species is that given by Bagg, from the vicinity of the Hawaiian Islands, *Albatross* station D4000, in 104–213 fathoms.

Brady figures specimens growing attached to the surface of the test of *Rhabdammina*. They are surrounded at their attachment by a light-colored material, probably related to the attached condition. This habit would tend to separate the species from true *Textularia*, which is typically free.

In some respects the species is not so greatly removed from certain species of *Verneuilina*.

TEXTULARIA GOËSII, new name.

Textularia sagittula DeFrance, var., Goës, Köngl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, pl. 5, figs. 150–158.

Textularia trochus H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 366, pl. 43, fig. 17 [not 15, 16, 18, 19]; pl. 44, figs. 1–3 [not *T. trochus* d'Orbigny].

Description.—Test broadly triangular in front view, subcircular in end view; in front view tapering abruptly to the apex, margins convex; chambers low and broad, sutures distinct, limbate, but not deep; wall more or less coarsely arenaceous but usually rather smoothly finished; aperture linear, in a depression at the base of the inner margin of of the chamber.

Length 0.85–2.25 mm.

Distribution.—This species occurs in rather shallow water in various parts of the North Pacific. Bagg records it from *Albatross* station D4000, in 104–213 fathoms, in the vicinity of the Hawaiian Islands, as *T. trochus*.

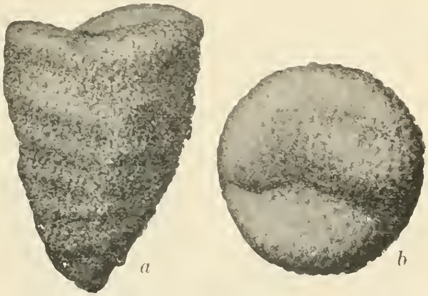


Fig. 24.—Textularia goësii. × 35. *a*, front view; *b*, apertural view (after Brady).

The synonymy of *Textularia trochus* illustrates well the rather interesting confusion that has arisen through the desire to unite fossil and recent species under the same name. Brady carried this union to an extreme, and the majority of later writers have been willing to follow the *Challenger* report blindly. The figure and description given by d'Orbigny of his typical *Textularia trochus* from the cretaceous of France both call for an entirely different form of test from the recent species usually passing under that name. In d'Orbigny's species the test is distinctly flaring with concave sides, the sutures flush and not limbate, and the broader apertural end of the test concave.

The common recent species has a tapering test, but instead of a broadly flaring later growth tends to increase in diameter less rapidly as it approaches the adult condition. As a result the sides, instead of becoming very concave are really convex, and rather strongly so. The sutures as a rule are limbate and the chambers typically overlap slightly, giving a test of greatly different appearance from d'Orbigny's figure.

After a study of a considerable series of foraminiferal material from various European Tertiary and other deposits, especially from France, I have been struck with the very considerable differences that appear between the species of these fossil faunas and recent material. The resemblances are for the most part small, and to unite any considerable number of these fossil species with the recent ones would mean ignoring the very real differences that exist. To unite them on the plea of great variation is not a position strengthened by a study of large series of recent material. Therefore, it has seemed to me best to call attention to certain of the apparent discrepancies that have originated in this way and to try to correct them.

TEXTULARIA RHOMBOIDALIS Millett.

Textularia rhomboidalis MILLETT, Journ. Roy. Micr. Soc., 1899, p. 559, pl. 7, fig. 4.

Description.—Test elongate, tapering, apical end rounded, apertural end broadly rounded, in end view quadrangular or rhomboidal, the sides slightly concave, the sutures distinct, somewhat depressed, curved; wall calcareous, hyaline, coarsely perforate; aperture a deep rounded opening; color white.

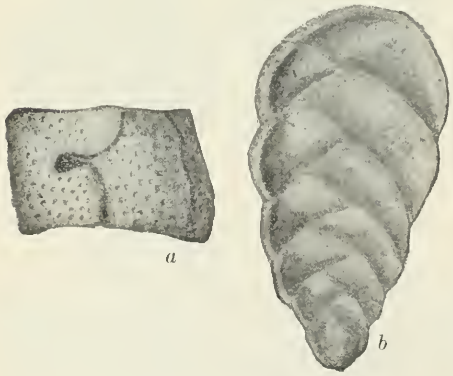


FIG. 25.—TEXTULARIA RHOMBOIDALIS. × 75. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

Length 0.34–0.60 mm.

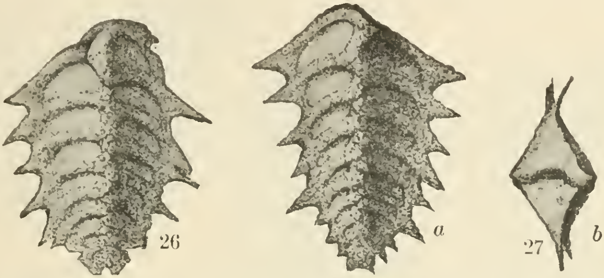
Distribution.—Not hitherto recorded from the North Pacific. One specimen was found at *Nero* station 2042, in 55 fathoms, near the Hawaiian Islands. From what may be learned of the distribution of this species, it is apparently confined to tropical and subtropical waters.

TEXTULARIA CARINATA d'Orbigny.

Textularia carinata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 263, No. 23; For. Foss. Vienne, 1846, p. 247, pl. 14, figs. 32–34.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 360, pl. 42, figs. 15, 16.—EGGER, Abh. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 270, pl. 6, figs. 39–41.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 284, pl. 29, fig. 1.

Plecanium carinatum SCHWAGER, Boll. R. Com. Geol. Ital., vol. 8, 1877, p. 26, pl., fig. 97.

Description.—Test somewhat elongate, fairly broad, much compressed toward the edges, sharply rhombic in end view; chambers low and broad, the sutures strongly limbate, running out into acutely pointed spines; wall coarsely arenaceous; aperture an elongate slit at the base of the inner margin of the chamber.



FIGS. 26-27.—TEXTULARIA CARINATA. × 30. 26, FRONT VIEW. 27, *a*, FRONT VIEW OF ANOTHER SPECIMEN; *b*, END VIEW (AFTER BRADY).

Length 1–1.5 mm.

Distribution.—The only North Pacific record for this species is that of the *Challenger* station 209, in 95 fathoms off the Philippines, where it is recorded by Brady as "tolerably abundant."

TEXTULARIA SIPHONIFERA H. B. Brady.

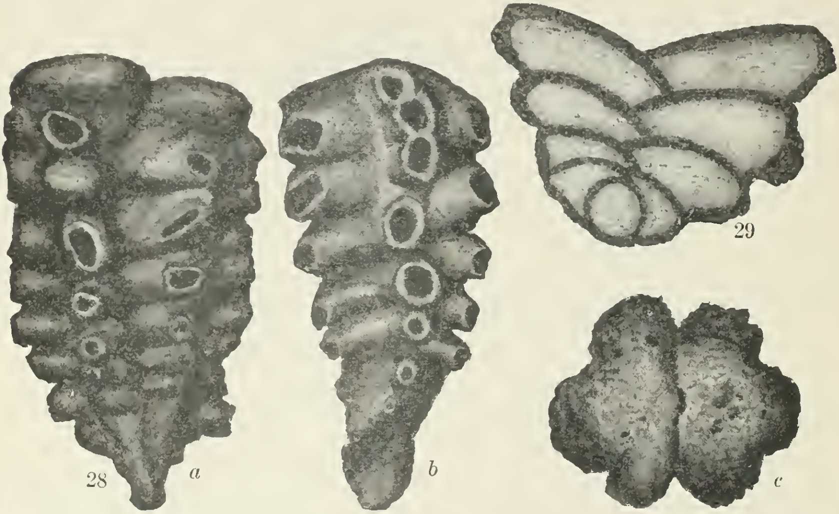
Textularia siphonifera H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 53; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 362, pl. 42, figs. 25–29.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 130.

Spiroplecta siphonifera CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 272, pl. 3, fig. 1.

Description.—Test free, elongate, subcylindrical, tapering toward the initial end, where it is often somewhat twisted and flattened; end view broadly oval with six or eight projecting portions; chambers low and broad, the earlier flattened and produced into fistulæ, the later with three or four projections, forming vertical rows with those of the chambers directly above and below; ends of the projections usually open, occasionally closed and bluntly rounded; wall arenaceous, of medium thickness; surface slightly roughened.

Length 1–2.5 mm.; megalospheric proloculum in one specimen 0.04 mm.

Distribution.—This species seems to be limited to the Indo-Pacific region and is best developed in shallow water in the vicinity of coral reefs. Brady records it from 40 fathoms on the coral reefs of Honolulu, Hawaiian Islands, and Bagg records it from a single *Albatross* station, H4567, in 1,307 fathoms off the same islands. This is probably a case similar to those already mentioned where currents have carried the tests of shallow water forms into the deeper water outside the reefs. I have noted the species at *Nero* station 2042 in 55 fathoms and *Albatross* station H3007 in 323 fathoms, both near the Hawaiian Islands, and *Albatross* station H4881 off Blake Reef, southern Japan, in 316 fathoms. This last station is the one already noted at which there is developed a decidedly southern coral reef fauna.



FIGS. 28–29.—TEXTULARIA SIPHONIFERA. 28, *a*, FRONT VIEW OF SPECIMEN WITH THREE PROJECTIONS ON EACH OF THE ADULT CHAMBERS; *b*, SIDE VIEW; *c*, END VIEW. × 40. 29, PROLOCULUM AND EARLY CHAMBERS BY TRANSMITTED LIGHT. × 300.

Chapman has found specimens of this species in which the megalospheric proloculum was followed by a short spiral, and refers the species to the genus *Spiroplecta*.

TEXTULARIA INCONSPICUA H. B. Brady.

Textularia inconspicua H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 357, pl. 42, figs. 6*a–c*.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 557, pl. 7, fig. 1.

Description.—"Test short, subconical, compressed laterally; distal end broadly elliptical, truncate or somewhat concave; apex rounded. Segments few, about six in each series, placed transversely; sutures flush externally. Walls thin, hyaline, perforate.

"Length $\frac{1}{100}$ inch (0.25 mm.)."

Distribution.—Brady recorded this species from three Pacific stations, one of which is in the North Pacific, *Challenger* station 232, in 345 fathoms on the *Hyalonema*-ground south of Japan. Millett records the species from the Malay Archipelago. I have not found the species in the material I have examined. The above description and figures are from Brady.

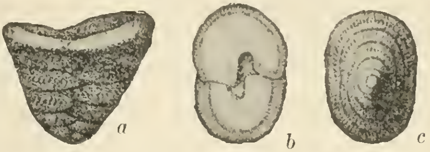


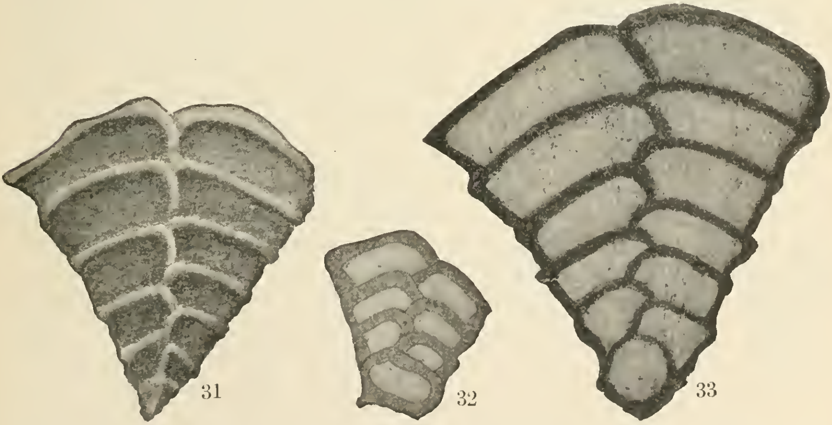
FIG. 30.—TEXTULARIA INCONSPICUA. × 70. *a*, FRONT VIEW; *b*, APERTURAL VIEW; *c*, APICAL VIEW (AFTER BRADY).

As noted by Millett this species has certain characters more like some of the Rotalidæ than like any of the other species of *Textularia*. In its aperture, also as figured both by Brady and by Millett, this same resemblance is noticed. It may be a *Discorbina*, with chambers extending half way about the circumference of the test, but a study of the apical characters and the arrangement of the early chambers should determine this.

TEXTULARIA FOLIUM Parker and Jones.

Textularia folium Parker and Jones, Philos. Trans. Roy. Soc. vol. 155, 1865, pp. 370, 420, pl. 18, fig. 19.—Möbius, Beitr. Meeresfauna Insel Mauritius, 1880, p. 92, pl. 8, figs. 16–17.—Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 357, pl. 42, figs. 1–5.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 272, pl. 6, figs. 27, 28.—Rhumbler, Zool. Jahrb., Abteil. Syst., vol. 24, 1906, p. 59, pl. 5, figs. 51, 52.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 130.

Description.—Test free, much flattened, broad, triangular in front view, in end view narrow, tapering toward the rather acute lateral margins; chambers broad and low in later development, earlier the less broad, the inner and distal margins thickened to form a raised ridge;



FIGS. 31-33.—TEXTULARIA FOLIUM. 31, FRONT VIEW. × 125. 32, EARLY CHAMBERS VIEWED BY TRANSMITTED LIGHT, SHOWING BROADLY OVAL PROLOCULUM WITH A SPINE. × 125. 33, SPECIMEN WITH SPHERICAL PROLOCULUM, BY TRANSMITTED LIGHT. × 175.

peripheral margin thin, surface smooth; wall fairly thick, clearly perforate, proloculum rounded or often somewhat quadrangular.

Length 0.18–0.54 mm., proloculum in rounded form 0.024–0.030 mm. in diameter, in quadrangular form 0.027–0.036 mm. high and 0.055–0.066 mm. in breadth.

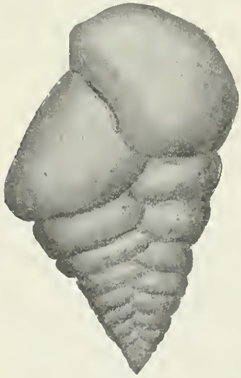
Distribution.—The distribution of this species is again in the Indo-Pacific region, although it was not found by Millett in the Malay Archipelago. It has been recorded from the Australian region, from about the Fiji and Admiralty Islands, and from Mauritius. From the Hawaiian Islands it was recorded on the coral reefs of Honolulu, 40 fathoms, by Brady, and from *Albatross* station H4017, in 305 fathoms, by Bagg. Rhumbler records it from shallow water at Laysan Island. I have noted specimens from two *Nero* stations off the Hawaiian Islands, 2033 and 2071, in 249 and 271 fathoms, respectively.

This in its form and ornamentation is in many ways a rather unique species. The occurrence of double tests has been noted by several writers.

TEXTULARIA APERTURALIS, new name.

Textularia solita (Schwager), var. *inflata* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 42, pl. 5, figs. 1–3.

Description.—Test tapering, triangular in front view, the initial end acute and compressed, the later portion inflated, with high chambers; the end view broadly oval; wall composed of very fine almost amorphous material, smooth; aperture a much elongated slit slightly above the base of the inner margin of the chamber, in adult specimens divided in the median plane to form two apertures; aperture often bordered by a slightly projecting raised rim; color white.



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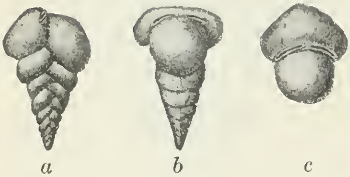

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Figs. 34-35.—Textularia aperturalis. 34. × 30. 35, *a*, front view; *b*, side view; *c*, end view. × 20? (Fig. 35, after Goës.)

Length 1.45 mm.

Distribution.—Goës described this species from *Albatross* station D3375 in 1,201 fathoms off the west coast of America.

An examination of Goës's original material does not seem to show the reason for uniting this species with *Textularia solita* (Schwager) even as a varietal form. With its peculiar inflated adult chambers and its tendency to divide the aperture, it seems to be a very distinctive species, and as *inflata* has already been used in this genus, I propose the above name for this species.

TEXTULARIA FLINTII, new species.

Textularia agglutinans FLINT (part), Rep. U. S. Nat. Mus., 1897 (1899), p. 284, pl. 29, fig. 4 (in part) [not *T. agglutinans* d'Orbigny].

Textularia rugosa BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 131 [not *T. rugosa* (Reuss)].

Description.—Test triangular in front view, irregularly rhombic in end view, rapidly increasing in size from the early portion, rather thick, but somewhat compressed laterally; chambers numerous, low and broad, inflated, separated by rather deep sutures; wall very finely arenaceous but smooth and shining; aperture an elongated slit slightly above the inner base of the chamber, often with a slightly raised lip.

Length about 1 mm.

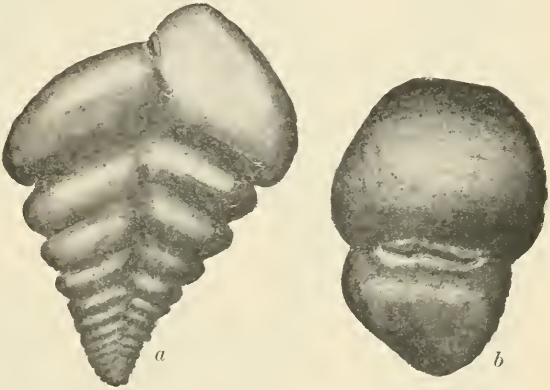


FIG. 36.—TEXTULARIA FLINTII. × 40. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

Distribution.—Specimens referred to this species were found at *Albatross* station H2899, 1,531 fathoms, east of the Hawaiian Islands, and at *Nero* stations 1294, 1,417 fathoms, off the Bonin Islands, and 1464 (type), in 891 fathoms, near Guam; also at *Tuscarora* station 58, in 814 fathoms, near the Bonin Islands. Bagg records this species under the name of *Textularia rugosa*, as a study of his selected material shows. The figured specimens were from *Albatross* station H4568, in 1,274 fathoms, near the Hawaiian Islands.

Type.—Cat. No. 8333, U.S.N.M.

In the figures given by Flint this species is confused with *Textularia agglutinans*. This species differs much from typical *T. agglutinans* in the greater lateral compression, the broader, more triangular form, the low broad chambers, the rhombic or almost quadrangular outline in end view and the broad aperture with its raised border above the base of the chamber, as well as in the much smoother and polished surface.

This species may be found to be rather common if it is carefully distinguished from the others with which it has been confused.

TEXTULARIA CRESCENTIFORMIS, new species.

Description.—Test elongate, slender, tapering, the initial end subacute, in side view crescentiform, gradually increasing in size from the initial end, in end view broadly rounded; chambers numerous, the earlier broad and low, becoming higher in later development and the last formed chambers higher than broad; sutures depressed and, with the somewhat tumid chambers, giving a sinuous outline to the test; wall arenaceous but of fine material and smoothly finished; aperture narrow, slightly above the base of the inner border of the chamber.

Length about 1 mm.

Distribution.—This species was found near the Hawaiian Islands at *Nero* station 2034, in 175 fathoms.

Type.—Cat. No. 8334, U.S.N.M.

This species in some respects resembles *Bolivina* but in most characters is a *Textularia*. The curvature of the test in side view is marked.

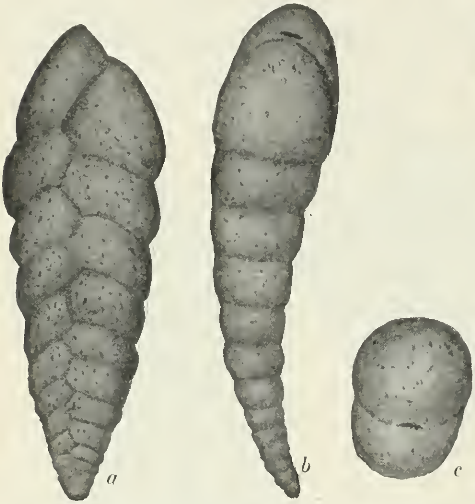


FIG. 37.—TEXTULARIA CRESCENTIFORMIS. × 75. *a*, FRONT VIEW; *b*, SIDE VIEW, SHOWING THE DISTINCT CURVATURE OF THE TEST; *c*, APERTURAL VIEW.

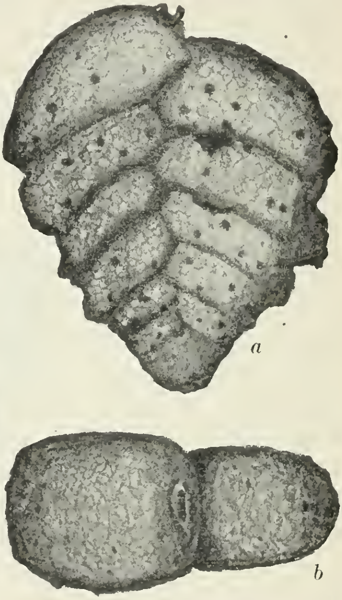


FIG. 38.—TEXTULARIA CONCAVA. × 60. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

TEXTULARIA CONCAVA (Karrer).

Plecanium concavum KARRER, Sitz. kais. Akad. Wiss., Wien, vol. 58, 1868. p. 129, pl. 1, fig. 3.

Textularia concava H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 360, pl. 42, figs. 11, 12 [not pl. 43, fig. 11].—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 271, pl. 6, figs, 3, 4 [?].—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 42.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 283, pl. 28, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 559, pl. 7, fig. 5.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 7, pl. 1, fig. 11.

Description.—Test tapering, becoming broad in the adult, compressed, broad faces often distinctly concave; chambers low and broad, squarely truncated laterally; wall arenaceous; aperture a narrowly elliptical opening, surrounded by a raised lip, somewhat above the base of the inner wall of the chamber.

Length 0.5–1.0 mm.

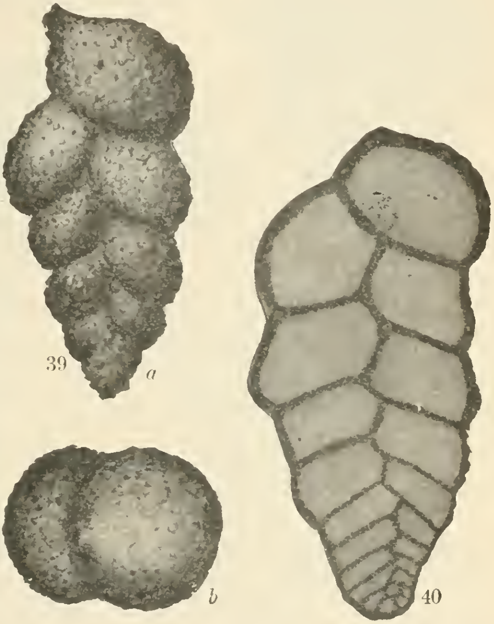
Distribution.—This species is apparently not common in the North Pacific. It has been noted occasionally in the material from about the Hawaiian Islands.

TEXTULARIA CATENATA, new species.

Description.—Test elongate, rounded in end view, composed of inflated chambers separated by rather deep sutures, making the outline of the test sinuate; wall somewhat coarsely arenaceous; aperture in the early chambers slit-like at the ventral border of the inner margin, in later chambers gradually moving away from the margin and in the last-formed chamber subterminal and rounded.

Length about 1 mm.; microspheric proloculum 0.022 mm.

Distribution.—This species was obtained from two *Nero* stations in the western North Pacific, station 1160 (type), in 1,907 fathoms and station 1320, in 2,048 fathoms. These stations are between Yokohama and Guam, one occupied on the northern voyage, the other on the return. They are but a few miles apart and the difference in depth is unimportant.



FIGS. 39–40.—TEXTULARIA CATENATA. 39, *a*, FRONT VIEW; *b*, APERTURAL VIEW. × 60. 40, ANOTHER SPECIMEN, MICROSPHERIC, BY TRANSMITTED LIGHT, SHOWING THE MICROSPHERIC PROLOCULUM FOLLOWED BY FOUR CHAMBERS IN A COIL BEFORE THE BISERIAL CONDITION IS TAKEN ON. × 120.

Type.—Cat. No. 8335, U.S.N.M.

The microspheric form of the species which is here figured has several small chambers in a coil about the proloculum. Then follows a series of broad low chambers, arranged biserially (fig. 40.)

Such species as this, with the terminal rounded aperture, have clearly essential characters different from the typical species of *Textularia* with the elongated aperture at the base of the inner border, yet these forms here described are evidently directly related to typical *Textularia* as is shown in their early development.

This species has a slight resemblance in its last chambers to *Gaudryina siphonella* Reuss, but is not a *Gaudryina*, having the biserial arrangement developed directly after the coiled series of chambers in the young.

TEXTULARIA CRASSISEPTA, new species.

Description.—Test broad, much compressed, in end view quadrangular, composed of rather few chambers, the earlier low and broad, the later shorter and comparatively high; walls coarsely arenaceous; borders of chambers much thickened and appearing as raised portions with depressed areas between; aperture becoming terminal some distance from the inner border of the chamber in the adult.

Length 0.8–1.0 mm.

Distribution.—This species was found at *Albatross* station H3007, in 323 fathoms, near the Hawaiian Islands.

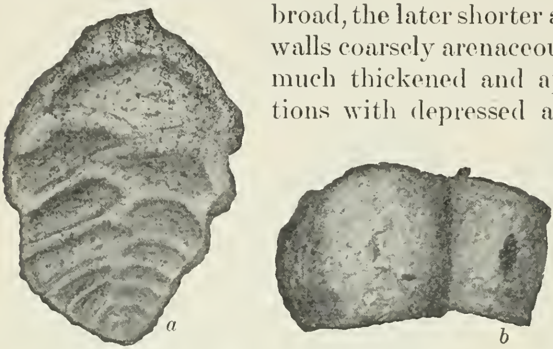


FIG. 41.—TEXTULARIA CRASSISEPTA. × 60. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

Type.—Cat. No. 8336, U.S.N.M.

In some respects this species suggests *Textularia concava*, but is readily distinguishable.

TEXTULARIA QUADRILATERA Schwager.

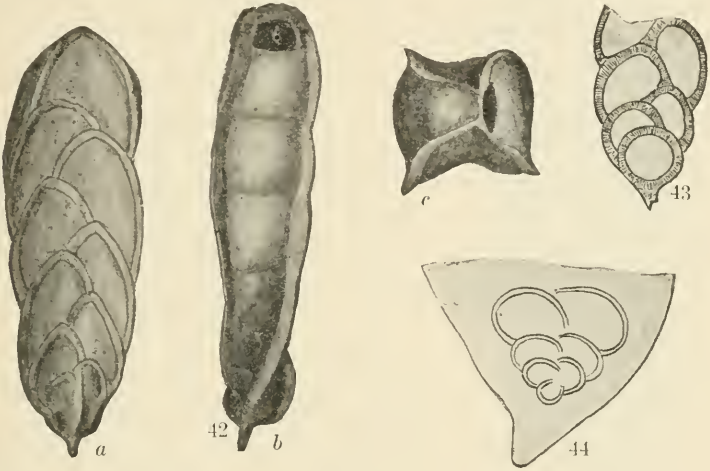
Textularia quadrilatera SCHWAGER, *Novara* Exped., Geol. Theil, vol. 2, 1866, p. 253, pl. 7, fig. 10.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 358, pl. 42, figs. 8-12.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 283, pl. 28, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 559, pl. 7, fig. 3.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 131.

Bolivina quadrilatera WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 475.

Description.—Test elongated, slender, very slightly tapering, in end view quadrilateral, the angles usually carinate; chambers high and narrow, running back obliquely on the outer border, compressed; the initial end of the test often with a stout spine, occasionally with several small spines or smooth and broadly rounded, the early chambers sometimes with one or more longitudinal raised costæ for a short distance; wall hyaline, distinctly perforate; aperture at one side near the distal end of the chamber, sometimes obliquely elongate, but somewhat variable.

Length up to 1.2 mm., megalospheric proloculum 0.076–0.115 mm., microspheric proloculum 0.012–0.023 mm.

Distribution.—The distribution of this species is very interesting. According to the *Challenger* report, it was found once in the South Atlantic and at a number of stations in the South Pacific, in from 410 to 1,350 fathoms. Flint records it from near Colon, Canal Zone, in 896 fathoms. Bagg records it from two stations near the Hawaiian Islands, station H4430, in 1,544 fathoms, and station H4568, in 1,274 fathoms. In the material I have examined it has occurred very frequently in the western North Pacific. Off the coast of Japan it was often noted in the *Albatross* material, and also in the *Nero* material from the line of soundings between Yokohama and Guam. The depths range from 191 to 891 fathoms, with a single record from 1,599 fathoms.



Figs. 42–44.—Textularia quadrilatera. 42, megalospheric form; *a*, front view; *b*, side view; *c*, apertural view. × 60. 43, optical section through the early chambers of a megalospheric specimen. × 60. 44, optical section through the early chambers of a microspheric specimen. × 275.

Both microspheric and megalospheric forms occurred in the material examined. In the microspheric form, which is not common, the proloculum is very small and the initial end of the test very tapering, the full width of the test not being attained until near its completion. The microspheric proloculum in the specimens examined varied from 0.012 to 0.023 mm. in diameter. In the megalospheric form the proloculum is much larger, often of nearly as great a diameter as that of the completed test and greater than the thickness of any other portion of the test. This form is therefore usually less tapering, with nearly parallel sides. The megalospheric proloculum varied from 0.076 to 0.115 mm. In the record kept the ratio of frequency of the megalospheric to the microspheric form was about 6 to 1.

This species, as has been suggested by various authors, is more like *Bolivina* in some respects than like the other species of *Textularia*. I have left it in the latter genus for the present, not without some doubts.

Both forms of the species are, so far as has been noted, without a coiled series of chambers in the early development of the test, a character which seems characteristic of the microspheric form in most species of *Textularia*. This would tend to place the species as a highly specialized one which in its acceleration of development had skipped this stage in its ontogeny even in the microspheric form.

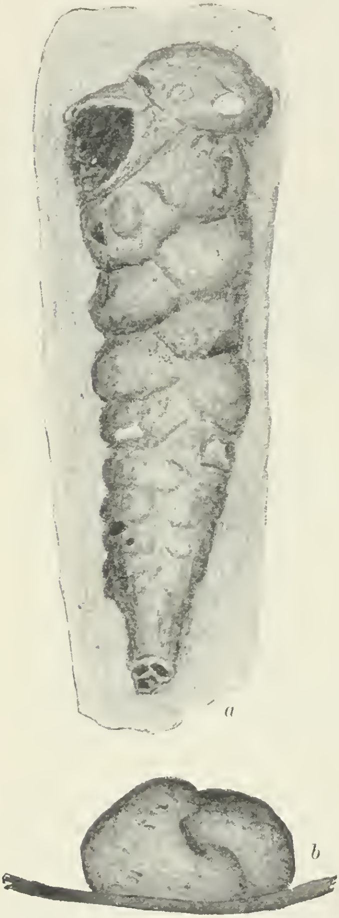


Fig. 45.—Textularioides inflata. × 30. *a*, front view; *b*, end view.

TEXTULARIOIDES, new genus.

Description.—Test attached, consisting of a *Textularia*-like series of chambers, arranged in two series, the chambers of one series alternating with those of the other; wall arenaceous; aperture an elongated slit in a depression at the base of the inner margin of the chamber.

Type of the genus.—*Textularioides inflata*, new species.

This genus is closely related to *Textularia*, being mainly distinguished by the attached habit and the consequent changes in the structure of the test.

TEXTULARIOIDES INFLATA, new species.

Description.—Test attached, elongate, slender, biserial, composed of alternating series of chambers, each slightly wider than high; sutures fairly distinct; chambers inflated, margin sinuous; wall coarsely arenaceous; aperture an elongated slit in a depression at the ventral border of the inner margin of the chamber.

Length 2.5 mm.

Distribution.—This species was found attached to a fragment of shell dredged by the *Albatross* at station D4900, in 139 fathoms, off the coast of Japan.

Type.—Cat. No. 8337, U.S.N.M.

Apparently this specimen is megalospheric, as the chambers immediately succeeding the proloculum are arranged biserially, with no trace of a coiled series of chambers. The species is a large and striking one.

Genus BIGENERINA d'Orbigny, 1826.

Bigenerina d'Orbigny (type, *B. nodosaria* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 261.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 368.

Description.—Test free, elongate, composed of a series of biserial chambers in the early portion, followed by several chambers uniserially arranged; aperture typically an oval or rounded opening near the middle of the terminal face; walls fairly thick, arenaceous, usually fairly coarse, but sometimes of fine material and smooth.

The specimen figured originally by d'Orbigny is rather characteristic. It has twelve biserially arranged chambers followed by a uniserial series of four chambers. In his sectional figure d'Orbigny shows the apertures of the early portion as truly textularian on the border of the inner margin of the apertural face, between it and the preceding chamber, while in the uniserial chambers it becomes a central opening in the middle of the terminal face of the chamber.

Later authors have included in this genus a great variety of species with characters not in accord with those established by d'Orbigny. Brady, in his synonymy, gives a long list of genera which he places wholly or in part in this genus.

As shown in *B. arenacea* Bagg, there are apparently both megalospheric and microspheric forms present. In the microspheric form the early chambers following the proloculum are coiled, as in the microspheric form of various species of *Textularia*, and like both forms in *Spiroplecta*. Later chambers are biserially arranged, as in *Textularia*, and those of the last formed group are arranged uniserially, giving the generic character. In the megalospheric form the coiled chambers may be wanting. As in other types, the microspheric form of the species attains the larger size.

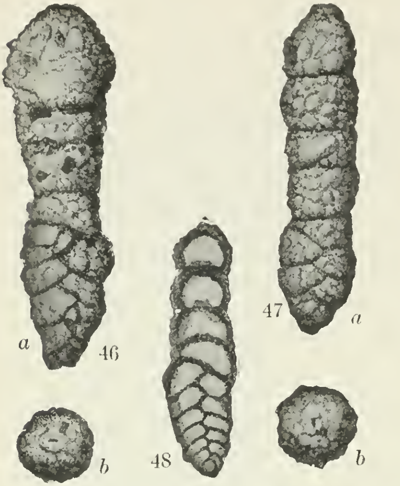
BIGENERINA NODOSARIA d'Orbigny.

Bigenerina nodosaria d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 261, pl. 11, figs. 9–11; Modèles, 1826, No. 57.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 28, pl. 2, fig. 62.—Terrigi, Atti. Acc. Pont. Nuovi Lincei, vol. 33, 1880, p. 192, pl. 2, fig. 28.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 369, pl. 44, figs. 14–18.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 37, pl. 7, figs. 313–315 [316–323?]; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 44.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 286, pl. 31, fig. 4.—Millett, Journ. Roy. Micr. Soc., 1899, p. 564, pl. 7, fig. 13.

Textularia agglutinans, var. *nodosaria* Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 371, pl. 15, fig. 25; pl. 17, fig. 80.

Clavulina elegans Karrer, *Novara* Exped., Geol. Theil, vol. 1, 1864, p. 80, pl. 16, fig. 11.

Description.—Test elongate, the early portion composed of a biserial group of chambers, considerably flattened and with the sutures clearly marked externally; chambers progressively broader; later portion composed of a uniserial group of chambers, rounded, usually less in width than the biserial portion; wall usually coarsely arenaceous, sometimes of fine material and nearly smooth; aperture in the early portion as in *Textularia*, an elongate slit between the base of the inner margin of the chamber and the adjacent wall of the preceding chamber, in the later portion rounded and in the middle of the terminal face of the chamber; color white or light gray.



Figs. 46–48.—Bigenerina nodosaria. × 35. 46, *a*, front view; *b*, end view. 47, *a*, front view; *b*, end view. 48, longitudinal section of the test (after Brady).

Length about 1 mm.

Distribution.—In the North Pacific this species is recorded by Brady in shallow water from three localities: China Sea; Hongkong Harbor, 7–10 fathoms; Inland Sea, Japan, 15 fathoms.

Outside the North Pacific it is widely distributed.

BIGENERINA DIGITATA d'Orbigny.

Bigenerina digitata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 262; Modèles, 1826, No. 58.—H. B. Brady, Trans. Linn. Soc., London, vol. 24, 1864, p. 468, pl. 48, fig. 8; Nat. Hist. Trans. Northumberland, vol. 1, 1865–67 (1867), p. 102, pl. 12, fig. 7.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 28, pl. 2, fig. 61.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 370, pl. 44, figs. 19–24.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.

Textularia agglutinans, var. *digitata* Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 371, pl. 17, fig. 81.

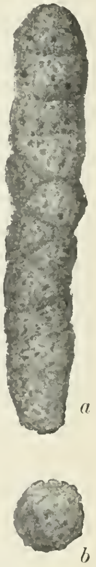


Fig. 49.—Bigenerina digitata. × 30. *a*, front view; *b*, apertural view.

Description.—Test fusiform or cylindrical, elongate, rounded in cross section, the early portion consisting of a number of chambers arranged biserially, but circular in cross section; sutures somewhat indistinct; apex bluntly rounded; later portion consisting of a number of chambers arranged uniserially; division between the two portions not marked by a difference in size; wall rather coarsely arenaceous, but the particles neatly cemented with a reddish brown cement to form a nearly smooth surface; aperture rounded, small, usually in the middle of the apertural face.

Length 1–1.6 mm.

Distribution.—Although this species has not heretofore been recorded from the Pacific, specimens from *Albatross* station D4949, in 110 fathoms on the coast of Japan, seem to belong to it. It occurs with numerous other species of the colder water area, which are similar to or identical with those of the northern Atlantic.

This species at first sight might be taken for a *Clavulina*, but the early chambers are biserial instead of triserial, as is the case in the early development of *Clavulina*. The species differs from the preceding in the early portion, which is here rounded, in *B. nodosaria*, being much flattened, and in the union between the biserial and uniserial portions, which are clearly distinguished in *B. nodosaria* by the difference in diameter of the test at that point, while in *B. digitata* the point of union is hardly distinguishable, except by the sutures.

BIGENERINA ARENACEA Bagg.

Bigenerina arenacea Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132, pl. 5, figs. 4–6.

Description.—Test flattened, fairly large, composed of a series of chambers arranged biserially, followed by a later portion made up of broad, somewhat arched chambers arranged uniserially, both portions much compressed; in cross section elongate oval; sides well rounded, not at all carinate; wall arenaceous, varying in coarseness, smoothly finished; aperture in the later portion an oval opening in the middle of the apertural face.

Length up to 3 mm.

Distribution.—This species was described by Doctor Bagg from several *Albatross* stations in the vicinity of the Hawaiian Islands. I have examined the type and other specimens returned to the National Museum, and have found specimens from two other *Albatross* stations, station H2999, in 549 fathoms, and station H2986, in 271 fathoms. A specimen from *Nero* station 990, in 859 fathoms, off Guam, apparently belongs to this species. It is somewhat more smooth and of finer material than usual, but this is probably due to local conditions of the bottom.

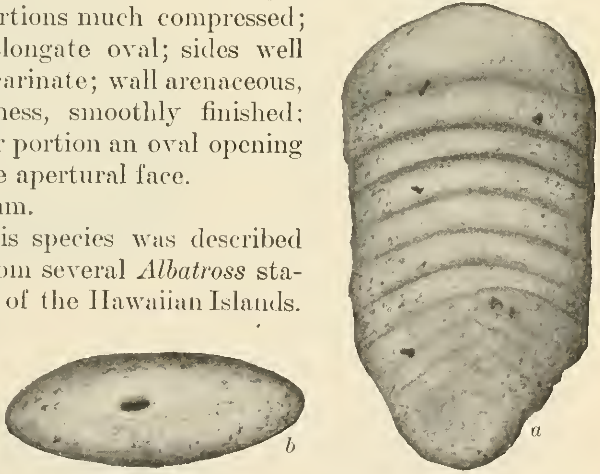


Fig. 50.—Bigenerina arenacea. × 30. *a*, front view; *b*, apertural view.

One additional feature not noted by the author is the tendency in the larger specimens to have the earliest chambers in a coil. Apparently this genus is related, as is *Textularia* and certain other genera, to an ancestral coiled form, as is indicated by the coiled arrangement of the earliest chambers in several genera of the family. This repetition of characters usually occurs only in the microspheric form of the species, which in this case as in many others seems to attain the larger size.

Genus PAVONINA d'Orbigny, 1826.

Pavonina D'ORBIGNY (type, *P. flabelliformis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 260.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 374.

Description.—Test calcareous, hyaline, perforate, many chambered, the early chambers biserial, the later embracing, each embracing portion composed of one or more chambers; apertures numerous at the peripheral margin of the chamber.

There seems to be but a single well-defined living species, which is rather widely distributed.

PAVONINA FLABELLIFORMIS d'Orbigny.

Pavonina flabelliformis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 260, pl. 10, figs. 10, 11; For. Foss. Vienne, 1846, p. 72, pl. 21, figs. 9, 10.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 27, pl. 1, fig. 22.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 282, pl. 8, figs. 29, 30.—MÖBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 91, pl. 8, figs. 13-15.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 374, pl. 45, figs. 17-22.—BASSET, Ann. Soc. Sci. Charente-Inf., 1884 (1885), p. 161, fig. in text.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132.

Pavonina flabelloides BRONN, Klassen und Ordnungen Thier-Reichs, vol 1, 1859, p. 72, pl. 6, figs. 13*a*, *b*.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 204, pl. 18, fig. 13.

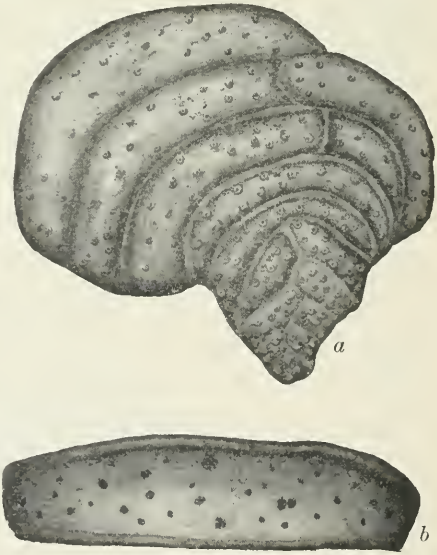


FIG. 51.—PAVONINA FLABELLIFORMIS. *a*, FRONT VIEW; *b*, APERTURAL VIEW. × 75.

Description.—Test free, many chambered, much compressed, the early portion consisting of chambers arranged biserially, the later portion spreading; chambers in a single series, elongated, forming a fan-shaped test; wall thin and transparent; apertures numerous on the peripheral wall, varying in size, and irregularly placed; wall porous, with numerous pores of good size more or less disposed in linear series, each with the wall immediately about it thickened and often slightly raised; color white, hyaline.

The diameter of the test rarely exceeds 1 mm.

Distribution.—This species seems to be rather rare, yet widely distributed throughout the warmer waters of the oceans. From the Pacific it has been recorded by Brady from the coast of Korea and from the coral reefs of Honolulu, in 40 fathoms; Bagg records it from *Albatross* station D4174, near the Hawaiian Islands, in 735–865 fathoms. I have seen specimens from three *Nero* stations, station 2042, in 55 fathoms, near the Hawaiian Islands, station 201, in 1,033 fathoms, near Midway Island, and station 1310, in 518 fathoms, near the Bonin Islands.

D'Orbigny's original figure shows the whole test without the biserial condition usually observed. Since the rediscovery by Möbius of the species in Madagascar sand, where d'Orbigny's type material was collected, it is clear that this is the species meant by d'Orbigny. The early portion was either obscure in his specimen or else it represents a megalospheric specimen without the biserial early stages. The later developed elongated chambers may run entirely across the periphery of the test or it may take two or even three chambers to complete the distance.

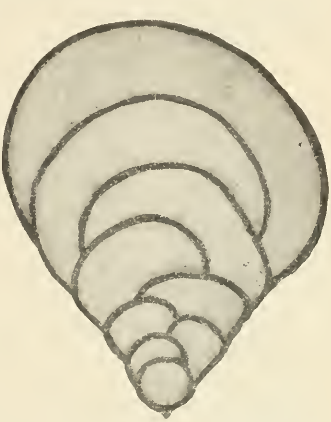


Fig. 52.—Pavonina flabelliformis. Young specimen viewed by transmitted light. × 150.

Genus BOLIVINA d'Orbigny, 1839.

Bolivina d'Orbigny, (type, *B. plicata* d'Orbigny) Voyage Amér. Mérid., vol. 5, pt. 5, 1839, p. 61.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 416.

Description.—Test elongate, distinctly biserial throughout; wall usually thin and hyaline in the young, but becoming thickened with age in many species, ornamented by punctæ, striæ, costæ, knobs and spines, with carinæ developed in some species; aperture elongate, usually wider at one end, usually symmetrical.

This genus includes a large number of species, most of which are of small size. In many cases the species seem to be very local in their distribution, as shown by the work of the *Challenger* and again in the present material. This is especially true of the species occurring in fairly shallow water in the tropical and subtropical seas.

Although resembling *Bulimina* in some ways, its affinities seem closer to *Textularia* and related genera. The aperture is not usually asymmetrical to any extent, as claimed by Brady.

A study of the microspheric and megalospheric forms in the different species should be made to determine whether or not there are coiled chambers in the early development of the microspheric form.

The species which exhibit a tendency toward a uniserial condition have been referred by some authors to *Bifarina*. The last two species in the present series may be so placed.

BOLIVINA PUNCTATA d'Orbigny.

Bolivina punctata d'Orbigny, Voyage Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 63, pl. 8, figs. 10-12.—H. B. Brady, Trans. Linn. Soc., London, vol. 24, 1864, p. 468, pl. 48, figs. 9, *a*, *b;* Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865–67 (1867), p. 103, pl. 12, figs. 8 *a*, *b*.—Möbius, Beitr. Meeresfauna Insel Mauritius, 1880, p. 94, pl. 9, figs. 9, 10.—Terrigi, Atti Acc. Pont. Nuovi Lincei, vol. 33, 1880, p. 197, pl. 2, fig. 41.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 417, pl. 52, figs. 18, 19 —Woodward and Thomas, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 169, pl. 3, fig. 12.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 743, pl. 14, figs. 10 *a*, *b*.—Malagoli, Boll. Soc. Geol. Ital., vol. 7, 1889, p. 375, pl. 14, figs. 1–4.—Terrigi, Mem. Com. Geol. d'Italia, vol. 4, 1891, p. 74, pl. 1, figs. 26–28.—Woodward and Thomas, Geol. Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 34, pl. c, figs. 27, 28.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 298, pl. 8, figs. 1–3.—Goës, Kongl. Svensk. Vet. Akad. Handl, vol. 25, No. 9, 1894, p. 49, pl. 9, figs. 475–478, 480.— Egger, Jahr. 16, naturhist. Ver. Passau, 1895, p. 12, pl. 1, fig. 11.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 47.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 38, fig. 1.—Wright, Geol. Mag. Dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 10.—Millett, Journ. Roy. Micr. Soc. 1900, p. 540.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 14.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1907, p. 32, pl. 4, fig. 80.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.—Cushman, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 28, pl. 5, fig. 13.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 274.

Bulimina presli, var. (*Bolivina*) *punctata* Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 376, pl. 17, fig. 74.

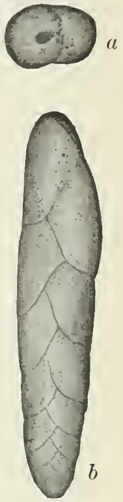


Fig. 53.—Bolivina punctata. × 100. *a*, apertural view; *b*, front view.

Description.—Test much elongated, straight or slightly curved, the apical end bluntly pointed, tapering very gradually to the apertural end; chambers numerous, somewhat compressed, the sutures slightly depressed, the chambers increasing in height as added; wall smooth, conspicuously but finely punctate; aperture an elongated slit, widest at the inner end; color white, brownish when living.

Length 0.40–0.85 mm.

Distribution.—Generally recorded from the North Pacific by Brady. Goës records it from several stations in the eastern Pacific in 695–1,882 fathoms, and Bagg records it at a number of stations in the vicinity of the Hawaiian Islands, in 104–1,544 fathoms. I have found the species well scattered in the North Pacific material that I have examined. The deepest record is *Nero* station 2049, in 2,226 fathoms, off the Hawaiian Islands.

A considerable variety of smooth forms have been assigned to this species, as a study of the references quoted will show. That there are several species or varieties present seems most likely. The variety with a portion of each chamber smooth, without punctæ, as noted by Millett, was found off the southern coast of Japan, and there may be other varieties with a definite distribution were sufficient material available from the different oceans.

The elongate form is not greatly removed from some forms of *B. nobilis*, except for the striations of the latter.

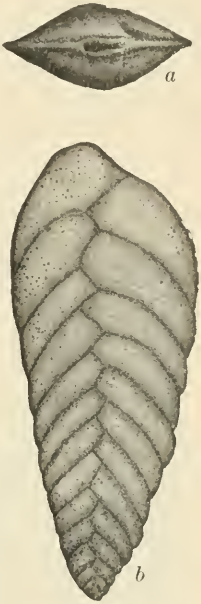


Fig. 54.—Bolivina dilatata. × 60. *a*, apertural view; *b*, front view.

BOLIVINA DILATATA Reuss.

Bolivina dilatata Reuss, Denkschr. Akad. Wiss., Wien, vol. 1, 1850, p. 381, pl. 48, fig. 15.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 197, pl. 2, fig. 42.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 418, pl. 52, figs. 20, 21.—Malagoli, Boll. Soc. Geol. Ital., ser. 4, vol. 6, 1887, p. 520, pl. 13, fig. 3.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 221, pl. 43, figs. 3, 6.—Terrigi, Mem. Com. Geol. d'Ital., vol. 4, 1891, p. 75, pl. 1, fig. 29.—Woodward and Thomas, Geol. Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 33, pl. e, fig. 26.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 294, pl. 8, figs. 17-20.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 50, pl. 9, figs. 482–486, pl. 14, figs. 5-10.—Egger, Jahr. 16, naturhist. Ver. Passau, 1895, p. 10, pl. 1, fig. 6.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 47.—Millett, Journ. Roy. Micr. Soc., 1900, p. 542.

Description.—Test cuneate, broadening rapidly toward the apertural end, the apical end small, blunt, much compressed, the edges thin; chambers numerous, broad and low, little inflated; sutures very distinct but hardly depressed; wall smooth, punctate; aperture elongate, narrow, ending at the edge of the inner border of the chamber; color white.

Length 0.3–0.6 mm.

Distribution.—Recorded by Goës from the eastern portion of the North Pacific in 695–1,832 fathoms, and by Bagg from the Hawaiian Islands, in 275–1,544 fathoms, with the average depth below 400 fathoms.

I have had material from *Nero* station 990, in 859 fathoms, near Guam, and from stations about Japan, in the Inland Sea, and in Bering Sea, from depths ranging between 120 fathoms and 898 fathoms. Specimens were nowhere common.

Although Reuss' name has been used for all the broader forms which could not well be included under *B. punctata* d'Orbigny by various writers, there is, as is seen from a study of the present material, a definite species with the characters given above. It is apparently very distinct from *B. punctata*, with chambers of a very different form.

BOLIVINA SEMINUDA, new species.

Description.—Test elongate, subcylindrical, very slightly compressed, the apical end rounded; chambers numerous, high, very slightly inflated, sutures nearly flush; wall hyaline, finely punctate except the lower half of each which has coarse foramina, otherwise smooth; aperture elongate, loop-shaped; color transparent and whitish about the lower half of each chamber.

Length up to 1 mm.

Distribution.— Specimens of this species were fairly common at two *Albatross* stations in Bering Sea, station H4025, in 536 fathoms, and station D4775 (type), on Bowers Bank, in 584 fathoms.

Type.—Cat. No. 8338, U.S.N.M.

The cylindrical form and the very peculiar ornamentation of the test distinguish this species. The test is hyaline and the lower half of the chamber, instead of being spinose or granular as in *B. spinescens*, is characterized by coarse foramina. No specimens were found except in Bering Sea.

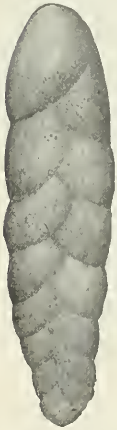


FIG. 55.—BOLIVINA SEMINUDA. × 60.

BOLIVINA BEYRICHI Reuss.

Bolivina beyrichi REUSS, Zeitschr. deutsch. geol. Gesellsch., vol. 3, 1851, p. 83, pl. 6, fig. 51.—HANTKEN, Mitth. Jahrb. Ung. geol. Anstalt, vol. 4, 1875 (1881), p. 64, pl. 7, fig. 11.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 198, pl. 2, figs. 43–45; vol. 35, 1883, p. 191, pl. 3, fig. 33.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 422, pl. 53, fig. 1.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 296, pl. 8, figs. 24–26.

Description.—Test elongate, rather narrow, much compressed, slightly tapering to the round-pointed apical end, apertural end evenly rounded, the chambers numerous, high at the posterior outer edge each projecting backward in a spinose projection; wall smooth, punctate; aperture elongate; color white.

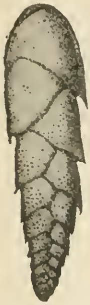


Fig. 56.—Bolivina beyrichi. × 50 (after Brady).

Length slightly less than 1 mm.

Distribution.—The only records in the North Pacific for this species are the two *Challenger* stations from which it was recorded by Brady, off the Philippines, in 95 fathoms, and on the *Hyalonema*-ground south of Japan, in 345 fathoms.

The figures of this species are very different, that of Hantken showing little it any of the posterior projections, and Egger's figure being very different from the usual form assigned to this species. From a study of the published figures and descriptions it seems very possible that our recent species may be found upon careful study to be different from the fossil.

BOLIVINA BEYRICHI Reuss, var. ALATA (Seguenza).

Vulvulina alata Seguenza, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 115, pl. 2, figs. 5, 5*a*.

Bolivina alata Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 296, pl. 8, fig. 27.

Bolivina beyrichi, var. *alata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 422, pl. 53, figs. 2–4.

Bolivina beyrichi, var. *carinata* Hantken, Magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), pl. 7, fig. 12; Mitth. Jahrb. Ung. geol. Anstalt, vol. 4, 1875 (1881), pl. 7, fig. 12.

Description.—Test differing from that of the typical form of the species by the wide peripheral flange; it is also broader and much more tapering.

Length about 1 mm.

Distribution.—Brady records this variety from one North Pacific *Challenger* station off the Philippines, in 95 fathoms. There is a specimen (figured) in the material which I have examined from *Albatross* station H4025, in 536 fathoms, near the Aleutian Islands, which seems to belong here and is not unlike the specimen figured by Brady in pl. 53, fig. 2, of the *Challenger* report.

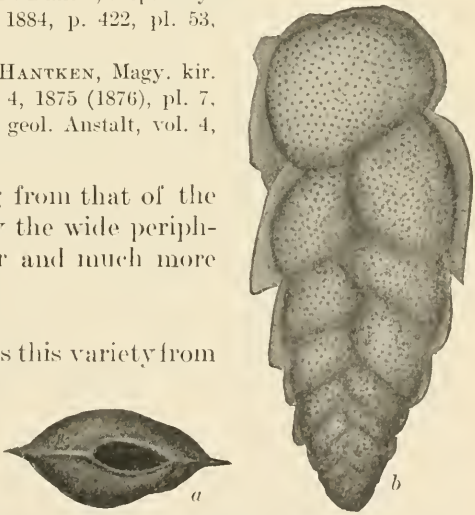


Fig. 57.—Bolivina beyrichi, var. alata. × 60. *a*, apertural view; *b*, front view.

BOLIVINA COMPACTA (Sidebottom).

Bolivina robusta H. B. BRADY, var. *compacta* SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 15, pl. 3, fig. 7.

Description.—Test elongate, tapering, the apex blunt-pointed, compressed, the edges rounded, the chambers numerous, somewhat inflated; sutures slightly depressed; surface areolated by the coalescence of the raised edges of the rather coarse punctæ; aperture elongate, with a slightly raised border; color silvery white.

Length about 0.60 mm.

Distribution.—Specimens which agree well with the figure and description given by Sidebottom have been found at various stations in the North Pacific. The relation to *Bolivina robusta* does not seem to be close enough to make it a variety of that species, and so I have raised it to specific rank.

It was secured near the Hawaiian Islands at *Albatross* station H3007, in 323 fathoms, and at two *Nero* stations in the same region, from Guam, and from a *Nero* station near the Philippines.

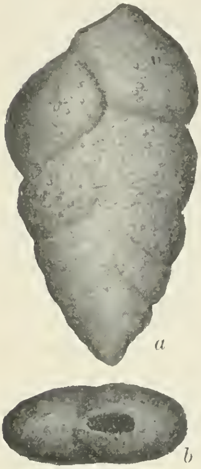


FIG. 58.—BOLIVINA COMPACTA. × 120. *a*, FRONT VIEW; *b*, END VIEW.

BOLIVINA ROBUSTA H. B. Brady.

Bolivina robusta H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 57; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 421, pl. 53, figs. 7–9.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 294, pl. 8, figs. 31, 32.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 543.—(?)CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1907, p. 32, pl. 4, fig. 82.—(?)BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.

Bolivina acaulis EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 295, pl. 8, figs. 28–30.

Description.—Test roughly triangular, tapering gradually to the apical end, which is either bluntly rounded or with a long, stout spine; apertural end very broadly rounded, almost obliquely truncate; test thickest at the median line, from which it slopes away to the fairly thin but rounded lateral edges; chambers numerous, longer than high, curved, in the later often crenulate with fairly deep reëntrants on the posterior margin; sutures scarcely depressed, limbate, curved; wall calcareous, thickly set with rather coarse perforations; aperture oval with a slightly raised lip; color white or gray,

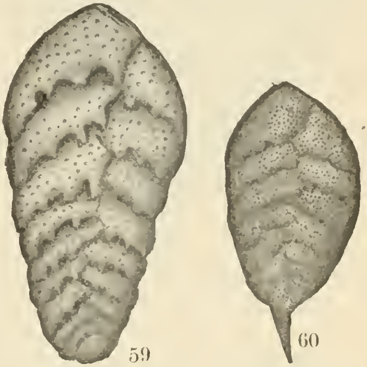
Length about 0.50 mm.; microspheric proloculum 0.011–0.012 mm.; megalospheric proloculum 0.047–0.050 mm.

Distribution.—From the North Pacific, Brady records this species as occurring at three stations in from 7–345 fathoms, the last being on the *Hyalonema*-ground south of Japan. Bagg records it from the vicinity of the Hawaiian Islands, but not all of his selected set are of this species, and none of them are at all typical.

From the 1906 cruise of the *Albatross* there is a large number of specimens representing many stations ranging in depth from 59 to 500 fathoms, mostly off the southern coast of Japan, from the region from which some of Brady's material was obtained, with one or two stations in the Eastern Sea. From the *Nero* material the species is represented from stations south of Yokohama in 660 to 2,119 fathoms, the latter being at the only station in this area from which the species has been obtained from more than 1,500 fathoms. There are a few specimens from *Albatross* station H3007, near the Hawaiian Islands, in 323 fathoms, and from *Tuscarora* station 58, in 814 fathoms, south of the Bonin Islands.

In the material, microspheric and megalospheric specimens have been found at the same station, and the measurement of the proloculum in several cases has been obtained. There seems to be no tendency toward coiled young in the microspheric form, so far as seen.

There is a considerable variation in the character of the lobulation of the posterior border of the chambers and in the presence or absence of the apical spine. Egger has described a species, *B. acaulis*, which seems to include those forms which lack the spine and have the lobulated margins of the chambers, but these characters are somewhat variable. The microspheric form is the more tapering of the two.



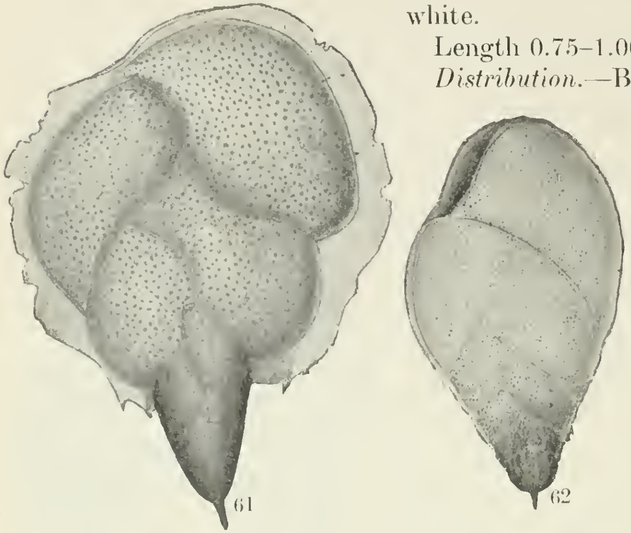
Figs. 59-60.—Bolivina robusta. 59, spineless variety with deeply lobed chamber margin. × 100. 60, typical specimen with apical spine and less deeply lobed margin. × 70.

The figures show the extreme forms as made out in the material. The spineless form with the deeper lobulations is that called *B. acaulis* by Egger.

BOLIVINA SEMIALATA Bagg.

Bolivina semi-alata Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 139, pl. 5, fig. 3.

Description.—Test broad, very much compressed, the early chambers in a conical, little compressed test, the later chambers broadening out, very much compressed, with a broad thin flange about the periphery; apical end acuminate, with a short, rather stout, spine; apertural margin very broadly rounded; posterior margin of the flange with short, posteriorly directed tooth-like projections; wall calcareous, thin, perforated with rather coarse perforations, smooth except for the apical end which may be slightly costate; aperture long and narrow, bordered by a raised lip formed by the flange bordering the chamber; color white.



FIGS. 61-62.—BOLIVINA SEMIALATA. × 75. 61, TYPE-SPECIMEN. 62, ANOTHER MORE REGULAR SPECIMEN FROM THE SAME REGION.

Length 0.75–1.00 mm.

Distribution.—Bagg described this species from two specimens from *Albatross* station H4555, in 1,398 fathoms, near the Hawaiian Islands. The type-specimen is figured here; the other was not seen.

I have had a single specimen from *Nero* station 2034, in 175 fathoms, also off the Hawaiian Islands. It is figured here. Apparently it is a younger and less developed specimen of this same species, with the apical portion slightly costate.

BOLIVINA SCHWAGERIANA H. B. Brady.

Bolivina schwageriana H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 425, pl. 53, figs. 24, 25.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 547, pl. 4, fig. 10.

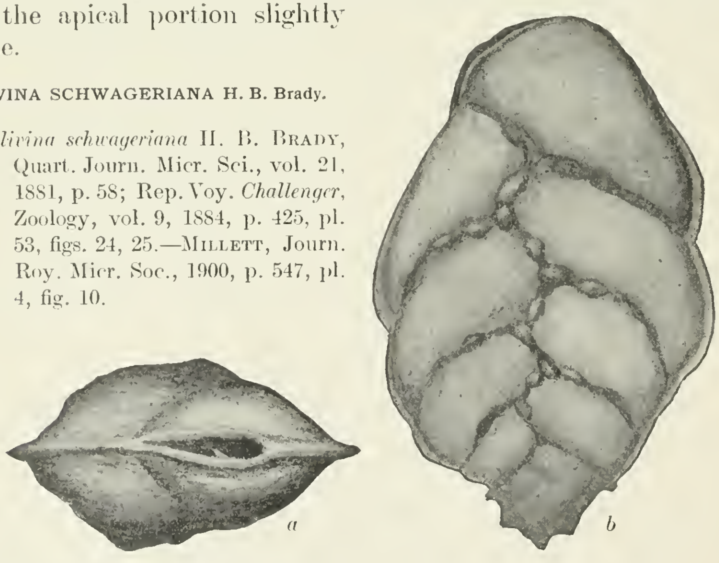


FIG. 63.—BOLIVINA SCHWAGERIANA. × 65. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

Description.—Test broad, a little longer than wide, compressed, thickest in the median line, thence curving gently to the carinate margins; apical end blunt, rounded; no keel developed on the early chambers, but in the later prominent though rather narrow; chambers well rounded; sutures limbate with raised beads near the junction with the chambers of the opposite series; wall calcareous, smooth except for the sutures and occasional costæ near the border of the test; aperture rather large, somewhat elongate, with an oblique projecting tooth; color white.

Length 0.50–0.65 mm.

Distribution.—This species has not previously been recorded from the North Pacific. Brady described it from specimens from Humboldt Bay, New Guinea, in 37 fathoms, and doubtful specimens from Torres Strait, in 155 fathoms. Millett records the species from the Malay Archipelago.

There are typical specimens from *Nero* station 1472, in 1,000 fathoms, near Guam. These are the only ones I have seen from the North Pacific. Apparently the species is limited to the Australasian region and the East Indian archipelago.

BOLIVINA NOBILIS Hantken.

Bolivina nobilis Hantken, Magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 56, pl. 15, fig. 4, Mitth. Jahrb. Ung. geol. Anstalt, vol. 4, 1875 (1881), p. 65, pl. 15, fig. 4.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 424, pl. 53, figs. 14, 15.—Chapman, Quart. Journ. Geol. Soc., vol. 48, 1892, p. 516, pl. 15, fig. 11.—Millett, Journ. Roy. Micr. Soc., 1900, p. 541, pl. 4, fig. 4.—Chapman, Journ. Linn. Soc. Zool., vol. 30, 1907, p. 32, pl. 4, fig. 81.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.

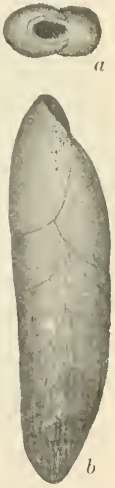


Fig. 64.—Bolivina nobilis. × 40. *a*, apertural view; *b*, front view.

Description.—Test much elongated, slender, somewhat compressed; sides nearly parallel but tapering rather quickly to a blunt point at the apical end, apertural end obliquely truncate; chambers numerous, high, somewhat inflated; sutures slightly depressed; wall calcareous, the apical portion with fine longitudinal costæ, the apertural end smooth; aperture oval, in some specimens, where a uniserial condition is attained, remote from the border and subterminal, otherwise reaching to the preceding chamber as also in the young; color white.

Length up to 1.20 mm.

Distribution.—All the *Challenger* stations for this species are in comparatively shallow water in the South Pacific. Bagg's records for the species are from *Albatross* station H4567, in 1,307 fathoms, and station H4696, in 367 fathoms, near the Hawaiian Islands. I have examined the specimens from these two stations and find that they are of the long slender type with finely costate apical ends.

I have specimens from five stations, *Albatross* station H2922, in 268 fathoms, station H3007 in 323 fathoms, *Nero* stations 2037 in 55 fathoms, 2064 in 1,355 fathoms and 2071 in 271 fathoms. All these five stations are close to the Hawaiian Islands.

These specimens as well as those which have been described by others are not very distinct from *B. punctata* except in the striations of the early chambers.

BOLIVINA KARRERIANA H. B. Brady.

Bolivina karreriana H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 424, pl. 53, figs. 19–21.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 299, pl. 8, figs. 38, 39.—Millett, Journ. Roy. Micr. Soc., 1900, p. 546.

Description.—Test elongate, tapering, the apical end occasionally rounded, but usually pointed with one large spine or two or more small ones; chambers comparatively few, inflated; sutures much depressed; wall calcareous, ornamented by longitudinal raised costæ, occasionally branching or anastomosing, continued even on the last-formed chamber; aperture broadly oval, subterminal, occasionally with a small tooth projecting into the orifice, bordered with a raised lip; color, white.

Length 0.50–0.80 mm.

Distribution.—Brady found this species abundant in material from the *Hyalonema*-ground south of Japan, in 345 fathoms. I have examined material from more than twenty stations, all in the region about Japan or to the southward. At some of these stations specimens are fairly common. The *Albatross* material from near the southern coast of Japan in most of stations from D4965 to D4975 contained this species. These stations are in the same region as the *Challenger* station mentioned above. They vary in depth from 191 to 905 fathoms. The species is well represented in the *Nero* material, mostly from the line of soundings between Guam and Yokohama. In depth these soundings range within the limits just given for the *Albatross* stations. In the *Tuscarora* material lately come under notice there is a single mounted specimen from station 2, which is south of the Hawaiian Islands, in 1,468 fathoms. The specimen is typical in all its characters.

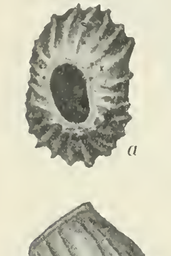


Fig. 65.—Bolivina karreriana. × 80. *a*, apertural view; *b*, front view.

The specimen recorded by Doctor Bagg from the vicinity of the Hawaiian Islands proves upon examination to be *Bulimina buchiana* d'Orbigny.

BOLIVINA KARRERIANA H. B. Brady, var. CARINATA Millett.

Bolivina karreriana H. B. Brady, var. *carinata* Millett, Journ. Roy. Micr. Soc., 1900, p. 546, pl. 4, fig. 8.

Description.—This variety has the test more compressed and larger than in the typical form, the aperture reaching to the preceding chamber instead of remote from it, and with the lateral borders distinctly carinate; the aperture is more elongate with a long tooth-like projection.

Length 0.75–0.80 mm.

Distribution.—Rare in the North Pacific, occurring but once, at *Nero* station 1472, in 1,000 fathoms, near Guam. Millett described this variety from the Malay Archipelago where it occurred at several stations.

Millett remarks upon the similarity of the variety to *B. hantkeniana* as well as to *B. karreriana*, and it may be that it is a distinct species. With but little available material I am leaving it as Millett has described it.

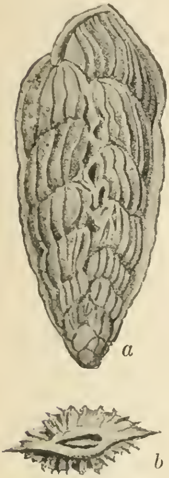


Fig. 66.—Bolivina karreriana, var. carinata. × 60. *a*, front view; *b*, apertural view (after Millett).

BOLIVINA PUSILLA Schwager.

Bolivina pusilla Schwager, *Novara*-Exped., Geol. Theil, pt. 2, 1866, p. 254, pl. 7, fig. 101.

Description.—Test elongate, tapering, composed of numerous rather low broad chambers, the apical end often with a very short spine, mucronate; wall ornamented with slightly raised longitudinal costæ, except at the apertural end where the chambers are usually smooth; aperture elongate, symmetrical; color, white.

Length about 0.40–0.60 mm.

Distribution.—This species is well distributed in the North Pacific in fairly deep water. It occurred at a large number of *Nero* stations from the Hawaiian Islands westward and along the coast of Japan. The shallowest record is near Japan, at *Albatross* station H4878, in 84 fathoms, and the deepest, *Nero* station 2049, in 2,226 fathoms, near the Hawaiian Islands. The larger number of records are from depths between 1,000 and 1,500 fathoms.

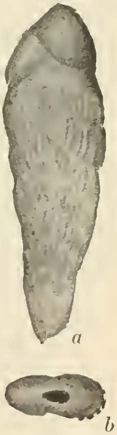


Fig. 67.—Bolivina pusilla. × 60. *a*, front view; *b*, apertural view.

These specimens seem to be identical with the species described by Schwager from the fossil deposits of Kar Nicobar. The loss of ornamentation in the later chambers of adult specimens is interesting.

BOLIVINA HANTKENIANA H. B. Brady.

Bolivina hantkeniana H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 424, pl. 53, figs. 16–18.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 296, pl. 8, figs. 40–42.—Millett, Journ. Roy. Micr. Soc., 1900, p. 546, pl. 4, fig. 9.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 137.

Description.—Test broad, much compressed, usually completely surrounded except at the aperture by a broad wing-like flange, either entire or variously lobed; chambers inflated somewhat; sutures very distinct, slightly depressed; wall calcareous, with a few short longitudinal costæ, usually confined to the limits of the chamber on which they originate; aperture narrow, oval, with a single tooth-like projection in the orifice; color, white.

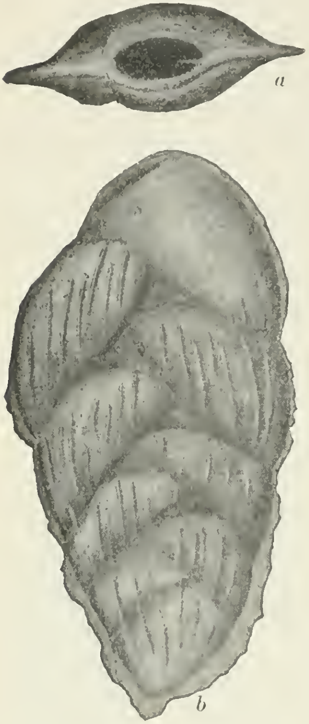


Fig. 68.—Bolivina hantkeniana. × 60. *a*, apertural view; *b*, front view.

Length 0.60–0.84 mm.

Distribution.—This species is recorded by Bagg from several *Albatross* stations in the vicinity of the Hawaiian Islands. While some of these specimens have the characters of this species, others I should refer to *B. beyrichi*, var. *alata*, and to *B. semialata*.

The only specimen I have which can without doubt be this species is from *Albatross* station D4970, in 500 fathoms, off the southern coast of Japan.

Brady's specimens were all from the Indo-Pacific region, and apparently this is a species limited to the warmer region from Australia northward, including the oceanic islands. This is the range of a large number of our species.

BOLIVINA AMYGDALÆFORMIS H. B. Brady.

Bolivina amygdalæformis H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 426, pl. 53, figs. 28, 29.

Description.—Test oval, compressed, the apical end round-pointed, the apertural end broadly rounded; chambers few, the sutures mostly hidden by the exterior ornamentation of the test, but showing slightly as darker lines; wall calcareous, ornamented by longitudinal costæ variously branching and anastomosing; terminal chamber, or sometimes the last two, nearly smooth, except for slight costæ at the lower border of the chamber, conspicuously and rather coarsely perforate; aperture terminal, in end view nearly central, long-oval, slightly constricted near the middle, bordered by a rounded raised lip; color, white or gray.

Length about 0.75 mm.

Distribution.—In the North Pacific, Brady records this species from *Challenger* station 209, in 95 fathoms, off the Philippines. I have seen specimens from two *Albatross* stations, D4875, in 59 fathoms, eastern channel of Korea Strait, and D4964, in 37 fathoms, off the southern coast of Japan. Brady also records the species from off the north coast of New Guinea, 1,070 fathoms, and in Torres Strait, in 155 fathoms.

The specimens I have had for study are of the same form and with the same details as those figured by Brady. The specimen figured by Egger[a] does not seem to be of this species and is referred elsewhere

BOLIVINA PLICATA d'Orbigny.

Bolivina plicata D'ORBIGNY, Voyage Amér. Mérid., vol. 5. pt. 5, "Foraminifères," 1839, p. 62, pl. 8, figs. 4–7.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.

This species is recorded by Goës from *Albatross* station D3395, in 730 fathoms, but an examination of the selected material mounted by Goës from this station shows it to be a new species, later described.

Bagg records *B. plicata* from a single station near the Hawaiian Islands, but his mounted specimen is unfortunately difficult to study, and dismounting was not attempted.

I have found no material in the North Pacific referable to this species.

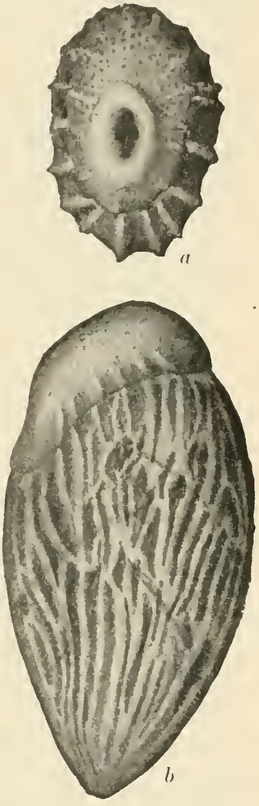


FIG. 69.—BOLIVINA AMYGDALÆFORMIS. × 75. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

BOLIVINA SEMICOSTATA, new name.

Bolivina costata H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 426, pl. 53, figs. 26, 27 (not *B. costata* d'Orbigny, 1839).

Description.—Test broadly oval, two-thirds as broad as long, the ends obtusely rounded, somewhat compressed; chambers few, the sutures distinct, somewhat depressed; wall calcareous, ornamented with a number of raised rounded costæ running lengthwise of the test, somewhat irregular; last one or two chambers usually smooth, carinate; aperture, in end view, central, terminal, broadly oval, with a raised, rounded border; color white.

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[a] Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 299, pl. 8, fig. 45.

Length 0.60–0.75 mm.

Distribution.—I have specimens of this species from *Nero* station 990, in 859 fathoms, off Guam. The oval specimens of Brady referred to above were from off Raine Island, Torres Strait, in 155 fathoms; in Humboldt Bay, off New Guinea, in 37 fathoms; and off Amboina, in 15–20 fathoms. Goës's specimen[a] does not belong here.

This species differs in several important characters from the typical form described by d'Orbigny. From the available records the species seems to be limited to tropical or subtropical waters.

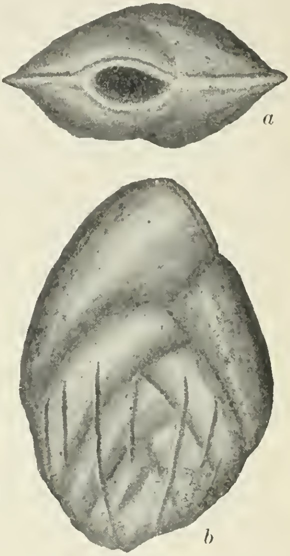

FIG. 70.—BOLIVINA SEMICOSTATA. × 75. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

BOLIVINA ÆNARIENSIS (Costa).

Brizalina aenariensis COSTA, Atti Acad. Pontaniana, vol. 7, 1856, p. 297, pl. 15, fig. 1, A. B

Bolivina aenariensis H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711, table; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 423, pl. 53, figs. 10, 11.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 221, pl. 43, figs. 2, 4, 5.—MALAGOLI, Boll. Soc. Geol. Ital., vol. 7, 1889, p. 377, pl. 14, figs. 11, 12.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 50.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 37, fig. 8.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 544.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 137 (part).

Bulimina punctata GOËS?, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, pl. 4, figs. 114, 115 (not *Bolivina punctata* d'Orbigny).

Description.—Test elongate, slightly tapering, much compressed, the edges carinate; apical end broadly rounded, often with a stout spine; apertural end rounded; chambers numerous, slightly inflated, the sutures curved, very slightly depressed; wall calcareous, smooth and punctate except for two or more longitudinal costæ, usually two long costæ extending well forward near the middle of the test, with shorter accessory ones near the apical end; aperture elongate-oval, with a continuation of the carina of the chamber forming a smooth raised lip about the opening; color white or gray.

Length up to 1.25 mm.

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[a] Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 48.

Distribution.—The species has been recorded by Brady at two North Pacific stations, off the Philippines, in 95 fathoms, and from the south coast of Japan, in 15 fathoms. Bagg records it from a number of *Albatross* stations near the Hawaiian Islands, but an examination of his material shows most of his specimens to belong to another species.

Typical specimens were found at a number of stations off the coast of Japan, in from 39–584 fathoms; also at three *Albatross* stations in Bering Sea, H4025, in 536 fathoms; D4781, in 482 fathoms; and D3608, in 276 fathoms. Specimens were abundant and large at station H2768, in 373 fathoms, near the coast of California. Specimens were also found at *Tuscarora* stations 32, in 309 fathoms, from the Californian coast; and 79, in 799 fathoms, near the Aleutian Islands.

The figured specimen did not have the typical long median costæ which are shown in Brady's figures and in the photographed specimens of Flint.

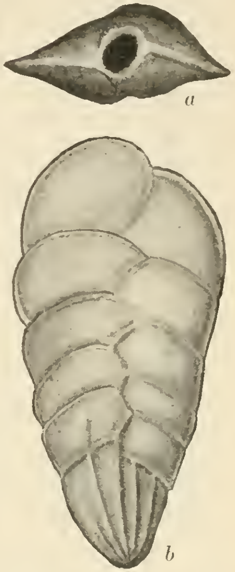
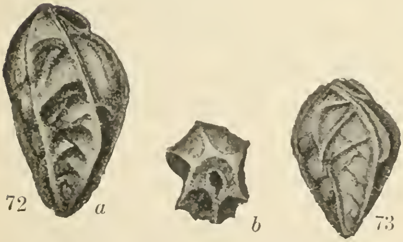


Fig. 71.—Bolivina ænariensis. × 40. *a*, apertural view; *b*, front view. Specimen without the long median costæ.

BOLIVINA SUBANGULARIS H. B. Brady.

Bolivina subangularis H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 427, pl. 53, figs. 32, 33.—Millett, Journ. Roy. Micr. Soc., 1900, p. 545.



Figs. 72-73.—Bolivina subangularis. × 60. 72, *a*, front view; *b*, apertural view. 73, front view of another specimen (after Brady).

Description.—"Test oblong, tapering, stoutly built, more or less angular, somewhat concave or excavated on both sides; aboral extremity obtusely pointed. The angular contour of the transverse section is determined by the prominence of superficial costæ, the principal of which, six in number, are placed, one down each lateral margin, and two down each face of the test. Aperture comma-shaped."

Length 0.5 mm. or less.

Distribution.—Recorded by Brady from *Challenger* station 209, in 95 fathoms, off the Philippines. I have not found specimens referable to this species. The description and figures are from Brady.

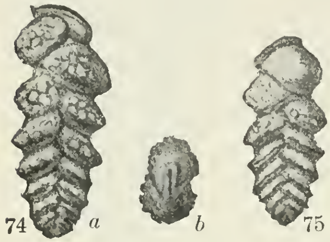
BOLIVINA LOBATA H. B. Brady.

Bolivina lobata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 425, pl. 53, figs. 22, 23.

Description.—"Test elongate, depressed, digitate; distal end obliquely truncate or rounded, aboral extremity obtuse, peripheral margin lobulated. Segments inflated, their outer margins projecting and subangular; sutures thickened, and deeply sunk; surface, especially of the later chambers, more or less granulated. Aperture a long oval slit contracted at the middle; nearly central."

Length 0.40 mm.

Distribution.—This species was described by Brady from the region about New Guinea. I have found it at a single station, *Nero* station 1583, in 777 fathoms, between Guam and Midway Island. The granulations of the surface and the form are similar. Egger's figures[a] do not seem to represent this species, but it is hard to judge from the quality of the figures in that work. Millett's figure[b] closely resembles *B. lobata*, but its connection with the young of *Bigenerina fimbriata* Millett makes it certain that it is a young of that species. If *B. lobata* had such a uniserial development, it seems that Brady's material would have shown it. Therefore, for the present, it seems best not to unite it, but to keep it with the species as described by Millett. The resemblance is, however, so striking that it may be that the uniserial form was present but overlooked or placed elsewhere. The question remains as to whether the figured specimen given by Millett is really the same as the type of *Bolivina lobata* H. B. Brady. If it is, then Brady's name should be used, although the genus would necessarily be changed.



Figs. 74-75.—Bolivina lobata. × 80. 74, *a*, front view; *b*, apertural view (after Brady).

The description and figures are from Brady.

BOLIVINA SPINESCENS, new name.

Bolivina textilarioides H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 419, pl. 52, figs. 24, 25 (not *Bolivina textilarioides* Reuss, 1862).—Millett, Journ. Roy. Micr. Soc., 1900,p. 542, pl. 4, fig. 5.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 139.

Description.—Test elongate, subcylindrical, the apex bluntly pointed; chambers numerous, inflated, the sutures fairly deep, the surface smooth except the portion at and just above the sutures, which is minutely spinose or granular; aperture large, loop-shaped, with a slightly raised border; color white or gray.

Length 0.50–0.75 mm.

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[a] Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, pl. 8, figs. 55, 56.

[b] Journ. Roy. Micr. Soc., 1900, pl. 1, fig. 4.

Distribution.—It is impossible to determine which of the two forms figured by Brady was obtained from the one North Pacific station given by him, Honolulu Reefs, 40 fathoms. However, an examination of Bagg's material labeled *B. textilarioides* shows the rough bordered form here described. In the *Nero* material I have had specimens from stations 2068, 2071, and 2074 in 307, 271, and 22 fathoms, respectively, the last being at Honolulu. Therefore Brady's specimens were probably of this species. There are also numerous specimens from the southern coast of Japan and from the area between Yokohama and Guam.

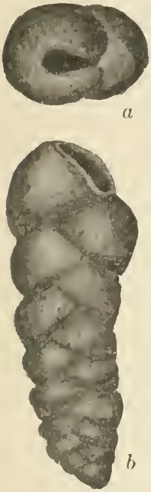


Fig. 76.—Bolivina spinescens. × 75. *a*, apertural view; *b*, front view.

Millett recognized two distinct forms in the Malayan material. This spinose or granular form, at least in the North Pacific, seems to be the more common, no specimens which could be assigned to Reuss's species being seen.

BOLIVINA DECUSSATA H. B. Brady.

Bolivina decussata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 423, pl. 53, figs. 12, 13.

Description.—Test broad, tapering to the rounded apical end; apertural end obliquely truncate, compressed, the edges thick and square, or somewhat rounded; chambers numerous, the sutures indistinct, the surface ornamented with a series of rounded bosses, arranged more or less in vertical rows and also in oblique rows across the test; aperture rounded, with a raised border; color white.

Length 0.50 mm.

Distribution.—The only records for this species are those given by Brady from off Juan Fernandez in the South Pacific. What certainly seems to be this species has occurred at *Albatross* station D4839, in 140 fathoms, off Japan. The form is similar and the surface has the peculiar raised ornamentation shown in Brady's figures.

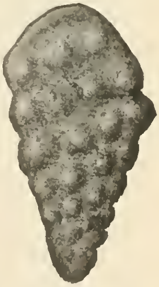


Fig. 77.—Bolivina decussata. × 120.

BOLIVINA LIMBATA H. B. Brady.

Bolivina limbata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 57; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 419, pl. 52, figs. 26–28.—Howchin, Trans. Roy. Soc. South Australia, vol. 12, 1889, p. 8.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 300, pl. 8, figs. 10–12.—Millett, Journ. Roy. Micr. Soc., 1900, p. 543.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 15.—Chapman, Journ. Linn. Soc., Zool., vol. 30, 1907, p. 32, pl. 4, fig. 83.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.

Description.—Test elongate, much compressed, gradually tapering to the rather bluntly-rounded apical end, often somewhat twisted, thickest along the median line, thinning toward the lateral margins, which are slightly rounded; chambers usually about as high as wide, slightly tumid, the sutures very distinct, irregularly curved, limbate, especially along the median portion of the face; wall calcareous, smooth, punctate; aperture elongate-oval, in some specimens somewhat remote from the border and terminal; color white.

Length 0.50–0.75 mm.

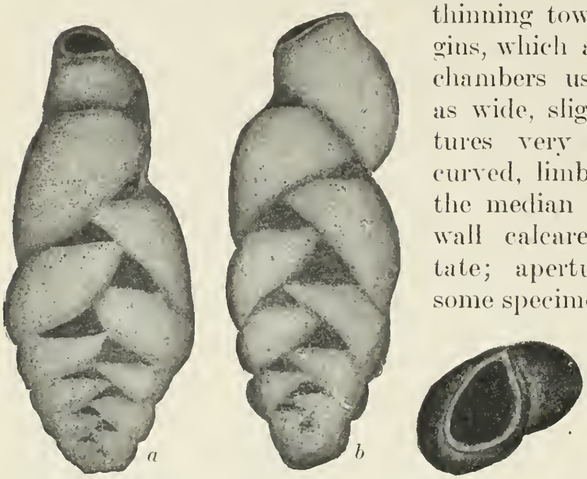


FIG. 78.—BOLIVINA LIMBATA. × 125. *a*, FRONT VIEW; *b*, SAME SPECIMEN FROM OPPOSITE SIDE; *c*, END VIEW.

Distribution.—Brady records the species from the following three stations in the North Pacific, off the Hawaiian Islands, in 40 fathoms, south shore of Japan, 15 fathoms, and in Hongkong Harbor, 7 fathoms. Bagg's specimen is from *Albatross* station H4694, in 865 fathoms, off the Hawaiian Islands.

In the material I have examined the species has been noted from the following stations: *Albatross* station D4965, in 191 fathoms, off the coast of Japan, and *Nero* station 1466, in 234 fathoms, near Guam.

There is a tendency in adult specimens to assume a uniserial development with a terminal aperture. From the other published records the species seems to be confined to fairly shallow tropical and subtropical waters.

BOLIVINA (BIFARINA) PORRECTA H. B. Brady.

Bolivina porrecta H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 57; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 418, pl. 52, fig. 22, *a*, *b*, *c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 300, pl. 8, figs. 7–9, 46, 47.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 38, fig. 2.

Bifarina porrecta MILLETT, Journ. Roy. Micr. Soc., 1900, p. 540, pl. 4, fig. 3.

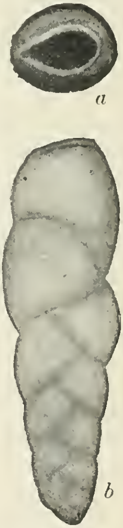


FIG. 79.—BOLIVINA (BIFARINA) PORRECTA. × 60. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

Description.—Test elongate, slightly tapering, the apex rounded; apertural end truncate, compressed, the edges rounded, the chambers high, the later triangular, the sutures in later growth passing entirely across the test and forming an almost uniserial stage; wall smooth, perforate; aperture subterminal, removed from the inner edge of the chamber, elongate, with a raised border; color white. Length 0.75–0.84 mm.

Distribution.—Not previously recorded from the North Pacific, but known from off Tahiti, the north coast of New Guinea, and from the Malay Archipelago. The only North Pacific station at which I have found the species is *Albatross* station D4875, in 59 fathoms, eastern channel of Korea Strait. This material is typical.

This species is referred to *Bifarina* by Millett, and if that genus be recognized that is its logical position.

BOLIVINA (BIFARINA) STRIGOSA (H. B. Brady).

Bolivina lobata, var. *strigosa* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 425, pl. 113, fig. 7.

Description.—Test elongate, slightly tapering, compressed; chambers triangular, the outer posterior angle extending outward, giving a very lobulated margin to the test; wall perfectly hyaline, except at the border, where it is partially white and opaque; sutures distinct, extending across the test in the later chambers; aperture elongate, subterminal, removed from the inner border of the chamber, surrounded by a raised lip; color transparent, white.

Length 0.40 mm.

Distribution.—Brady described this as a variety of *B. lobata* from Torres Strait. The figured specimen from *Nero* station 1310, in 518 fathoms, between Yokohama and Guam, is in every respect identical with Brady's specimen. The resemblance to *B. lobata* seems to be remote, and it is here considered as a distinct species.

In this same region and at corresponding depths many of the other species described from Torres Strait are found, and it is not surprising to find this rare form here also. The arrangement of the last-formed chambers strongly suggests *Bifarina*.

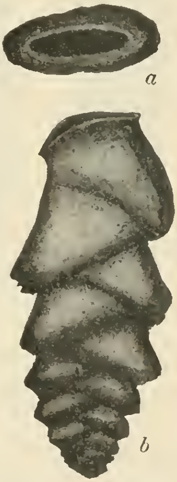


Fig. 80.—Bolivina (Bifarina) strigosa. × 120. *a*, apertural view; *b*, front view.

Genus PLEUROSTOMELLA Reuss, 1860.

Nodosaria (part) Reuss, Verst. Böhm. Kreid., pt. 1, 1845, p. 28.

Dentalina (part) Reuss, Haidinger's Nat. Abhandl., vol. 4, 1850, p. 24.

Pleurostomella Reuss (type, *P. subnodosa* Reuss.), Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 203.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 410.

Description.—Test elongate, somewhat compressed, composed of numerous chambers, usually biserially arranged; wall calcareous, perforate, smooth or ornamented; aperture distinctive, an arched opening with a vertical notch or slit in the middle of the lower edge, usually with tooth-like projections upward at either side.

The aperture is really the distinguishing character of this genus. It differs much from that of the other genera of the family, and there are considerable differences in the various species, some having a simple vertical slit without teeth, others a broad notch with a well developed tooth at each side. This wall containing the slit or notch is usually well within the arched space, and is not always easy to see when examining material. There are several described species, but none of them seem to be at all common. None of the species have previously been recorded from the North Pacific.

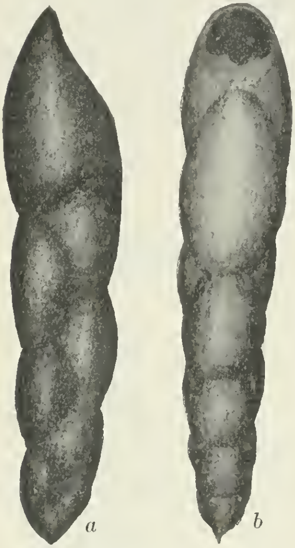


Fig. 81.—Pleurostomella alternans. × 60. *a*, front view; *b*, view showing aperture.

PLEUROSTOMELLA ALTERNANS Schwager.

Pleurostomella alternans Schwager, *Novara* Exped., geol. Theil, vol. 2, 1866, p. 238, pl. 6, figs. 79, 80.—Terrigi, Atti. dell' Accad. Pont., ann. 33, 1880, p. 199, pl. 2, fig. 46.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 412, pl. 51, figs. 22, 23.—Chapman, Proc. Zool. Soc. London, 1895, p. 25.

Description.—Test elongated, compressed, very gradually tapering from the subacute base; apertural end acute in front view, in side view broadly rounded; chambers numerous, longer than wide; sutures slightly depressed; aperture broadly arched; notch of the lower wall broad, almost semicircular, with an acutely pointed tooth projecting forward on each side; wall smooth and polished; color white.

Length 0.60–0.85 mm.

Distribution.—There is a single specimen in the collection from *Albatross* station D2806, in 1,379 fathoms, off the Galapagos Islands. It has not been met with in material from any other part of the North Pacific.

Whether or not this species is really *P. alternans* Schwager may be open to question. That species, as the original figures show, has a very high vertical wall in which the aperture is seen near the top as a relatively small opening. In the recent specimens figured this opening is much larger and broader.

PLEUROSTOMELLA SUBNODOSA (Reuss).

Nodosaria nodosa REUSS (part), Verst. Böhm. Kreid., pt. 1, 1845, p. 28, pl. 13, fig. 22.
Dentalina subnodosa REUSS (part), Haidinger's Nat. Abhandl., vol. 4, 1850, p. 24, pl. 1, fig. 9.
Pleurostomella subnodosa REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 204, pl. 8, fig. 2*a*, *b*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 412, pl. 52, figs. 12, 13.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 25.

Description.—Test much elongated, very slightly compressed, nearly cylindrical, hardly tapering, the apical end broadly rounded, the apertural end subacute in front view, rounded in side view; chambers several, the very early ones biserial, the later uniserial, but with oblique sutures showing the traces of the biserial condition; aperture fairly broad; sinus broad with slight projections at each side; color white.

Length 0.65–0.90 mm.

Distribution.—Apparently this species is more common in the North Pacific than the preceding. It was found in material from *Tuscarora* station 2, in 1,468 fathoms, in the southwestern Pacific, *Nero* station 842, in 1,330 fathoms, off the coast of Luzon, Philippine Islands, and at *Nero* stations 1294 and 1299, in 1,417 and 1,817 fathoms, south of Japan.

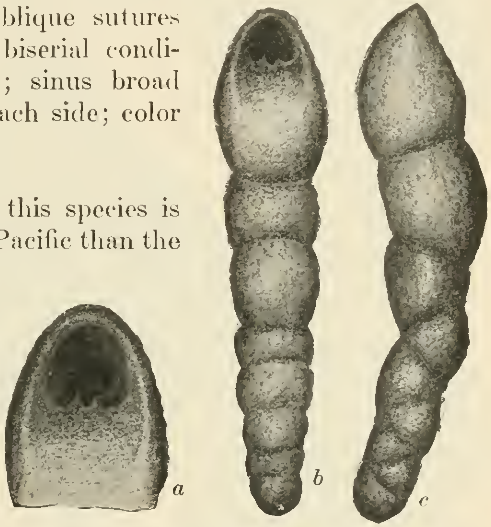


FIG. 82.—PLEUROSTOMELLA SUBNODOSA. *a*, APERTURE. × 150; *b*, FRONT VIEW; *c*, SIDE VIEW. × 75.

The early portions of the test show biserially arranged chambers and the later ones while uniserial are really a biserial series, which shove one another apart, as is seen by the arrangement of the sutures and the wedge-shaped chambers alternating from side to side as added.

PLEUROSTOMELLA SPINOSA, new species.

Description.—Test broad, abruptly tapering to the acute spinose apical end; chambers several, greatly increasing in size in the adult, broad and much inflated, the sutures deep; surface with numerous very short subacute spines, either over all the chambers or limited to the earlier ones; aperture with the sinus a narrow slit with bluntly rounded short teeth at the sides; color white.

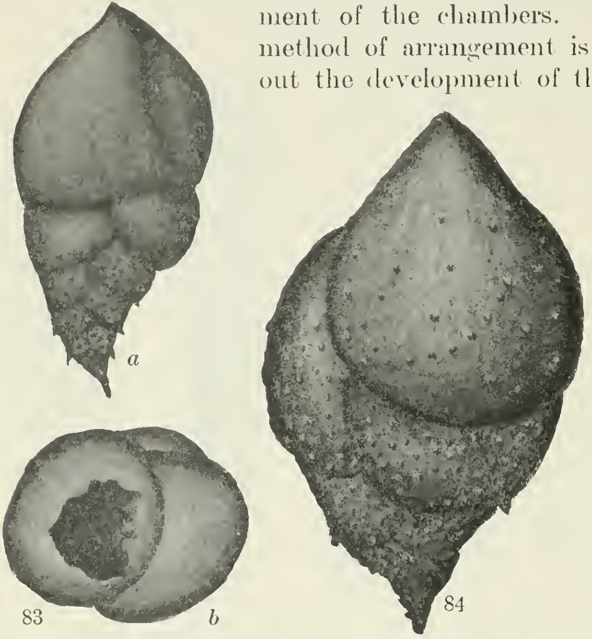
Length 0.50–0.70 mm.

Distribution.—Type-specimen (Cat. No. 8339, U.S.N.M.) from *Albatross* station D4970, in 500 fathoms, off Japan. Two other specimens were found at this station.

This species differs from the other abruptly tapering species of the genus by its more depressed sutures and its spinose surface.

Subfamily 3, VERNEUILININÆ.

This subfamily includes those genera which, at least in their early development, have a distinctly triserial arrangement of the chambers. In *Verneuilina* this method of arrangement is continued throughout the development of the test, but in other genera becomes variously modified. In *Gaudryina* the early portion of the test is triserial and the adult arrangement is biserial and comparable to *Textularia*. In *Clavulina* there is still another regressive step and the young are triserial, while the adult arrangement is uniserial with a central aperture.



FIGS. 83–84.—PLEUROSTOMELLA SPINOSA. ×75. 83, *a*, FRONT VIEW; *b*, APERTURAL VIEW WITH THE UPPER END OF THE CHAMBER SLIGHTLY BROKEN AND JAGGED. 84, FRONT VIEW OF ANOTHER MORE INFLATED SPECIMEN.

Genus VERNEUILINA d'Orbigny, 1840.

Verneuilina D'ORBIGNY (type, *V. tricarinata* d'Orbigny), Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 38.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 382.

Bulimina (part), REUSS, Verst. Böhm. Kreid., pt. 2, 1845, p. 109, and other authors.

Polymorphina (part), SCHULTZE, Organ. Polyth., 1854, p. 61.

Textularia (part). PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 371 and other authors.

Description.—Test free, more or less elongate, tapering, in cross section rounded or triangular, composed of a series of chambers spirally arranged, but in three vertical columns; walls variable, arenaceous or hyaline; aperture a slit at or near the base of the inner margin of the chamber.

In general the genus *Verneuilina* may be used to include all the definitely triserial species which have a slit-like aperture at the base of the inner margin of the chamber. This is apparently the primitive genus from which have developed such genera as *Gaudryina,* and in its relations to *Textularia, Verneuilina* may be taken as the simplest member of the subfamily *Verneuilininæ.* It includes a number of well characterized species, some of them rather common and of wide distribution.

VERNEUILINA POLYSTROPHA (Reuss).

Bulimina polystropha Reuss, Verst. Böhm. Kreid., pt. 2, 1845, p, 109, pl. 24, fig. 53.
Verneuilina polystropha Parker and Jones, Introd. Foram., 1862, p. 311.—H. B. Brady, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 436, pl. 20, figs 9*a–c*.

Description.—Test elongate, conical, triserial, the apical end bluntly rounded, the chambers somewhat inflated; wall coarsely arenaceous, the surface rough; aperture at the base of the inner margin of the chamber, in a depression formed at the junction of the three chambers, rounded or oval; vertical columns of chambers usually spirally twisted; color reddish brown.

Length 0.50–1.0 mm.

Distribution.—This shallow water species has heretofore not been recorded from the North Pacific. Specimens from two *Albatross* stations, H2681, in 486 fathoms, and H2772, in 343 fathoms, off the western coast of the United States, seem referable to it as figured by Brady. Whether this is really the species described by Reuss from the cretaceous is very doubtful, but for the present it is so considered.

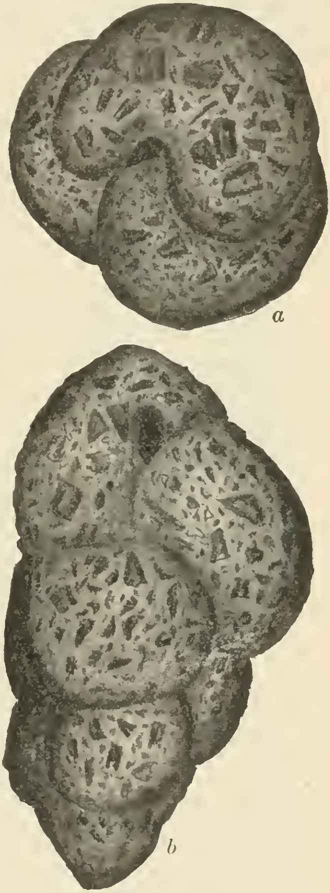


Fig. 85.—Verneuilina polystropha. × 30. *a*, apertural view; *b*, front view.

VERNEUILINA PROPINQUA H. B. Brady.

Verneuilina propinqua H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 387, pl. 47, figs. 8–12 [not 13, 14].—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 33, pl. 7, figs. 264–266.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 285, pl. 31, fig. 2.

Description.—Test free, pyramidal, triserial, the apical end bluntly rounded; chambers well inflated but closely set; wall coarsely arenaceous, the surface somewhat rough or nearly smooth; aperture elongate at the base of the inner margin of the chamber; color brown.

Length up to 3.6 mm.

Distribution.—Brady records this species from three *Challenger* stations in the southwestern portion of the North Pacific, in 95, 2,050, and 2,900 fathoms. Goës records the species, but his Pacific material belongs to the following species, and his Atlantic is *V. bradyi*. In the *Albatross, Nero,* and *Tuscarora* soundings the species has occurred at a number of stations from off California to the coast of Japan. Its most shallow occurrence is 905 fathoms and the deepest 2,086 fathoms.

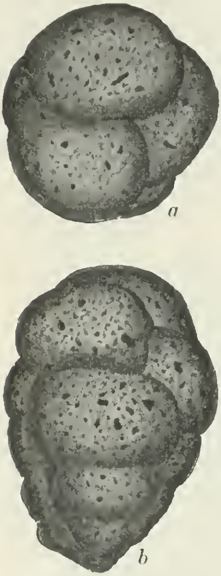


Fig. 86.—Verneuilina propinqua. × 35. *a*, apertural view; *b*, front view.

The vertical columns of chambers are straight as in *V. bradyi* and show no tendency toward the spiral form as in *V. polystropha.*

VERNEUILINA BRADYI, new name.

Verneuilina pygmæa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 385, pl. 47, figs. 4–7 (not *Bulimina pygmæa* Egger).—Flint, Rept. U. S. Nat. Mus., 1897 (1899), p. 285, pl. 31, fig. 1.

Verneuilina propinqua Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 38 (part).

Description.—Test pyramidal, the triserial chambers inflated, the wall finely arenaceous; about five visible chambers in each vertical series; surface smooth, but not usually polished; aperture an elongated slit near the base of the inner margin of the chamber, occasionally with a thickened lip; color light gray.

Length 0.60–1.50 mm.

Distribution.—Apparently this species is widely distributed in the deeper water of all the oceans. The only North Pacific records are those of Brady, who found the species in material from six *Challenger* stations in this area ranging in depth from 1,850–3,125 fathoms. In the material which I have examined the species has occurred many times. No station with a depth of less than 1,000 fathoms gave specimens of this species. This accords with Brady's observations on the *Challenger* material, where but 8 out of 42 stations at which this species occurred were of a depth of less than a thousand fathoms, and 14 were greater than 2,000. Only one of our stations is below the 2,000 fathom mark, though several are close to it. The shallowest station from which I have seen specimens had a depth of 1,040 fathoms. In general the stations are well scattered over the area of the North Pacific where dredging has been done, except that it did not occur in the 1906 soundings from about Japan. Most of the work done here, however, was in more shallow water.

There has been considerable doubt in the minds of various authors as to the correctness of assigning our recent species to the somewhat incomplete figure of *Bulimina pygmæa* given by Egger.[a] Brady remarks upon the doubtfulness of using Egger's name for this species. Goës also is inclined to question the identity.

From a study of the available data it seems to me very unwise to refer our well characterized recent species to the very doubtful and ill characterized fossil species. Egger's figure does not at all represent our common recent species nor does the later figure given by Goës.[b] Neither *Textilaria triseriata* Terquem nor *Verneuilina rotundata* Karrer are clearly this species, certainly not the former, although both are included by Brady under *V. pygmæa*. In such a case it seems best to use a new name for our recent species, and from the clear description and excellent figures given by Brady his name is used here for the species.

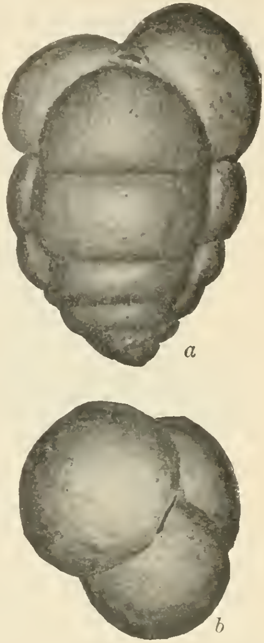


FIG. 87.—VERNEUILINA BRADYI. × 40. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

An examination of the series selected by Goës shows that a part of his specimens referred to *V. propinqua* are in reality *V. bradyi* and not *V. propinqua* H. B. Brady.

VERNEUILINA SPINULOSA Reuss.

Verneuilina spinulosa REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 374, pl. 47, fig. 12.—EGGER, Neues Jahrb., 1857, p. 292, pl. 9, figs. 17, 18.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 384, pl. 47, figs. 1–3.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 42, fig. 15 (not fig. 14).—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 472.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 11.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 10, pl. 2, fig. 5.—RHUMBLER, Zool. Jahrb., Abth. Syst., vol. 24, 1906, p. 61, pl. 5, fig. 53.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132.

Description.—Test pyramidal, three-sided, triangular in transverse section, the sides flat or slightly concave, the initial end acutely pointed; initial end and angles of chambers often with sharp spines; walls of medium thickness, hyaline, or in some cases thickened and rough, perforate, smooth or granular; apertural end of test bluntly angled, the edges of the chambers thickened; aperture a curved slit at the base of the inner edge of the chamber.

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[a] Neues Jahrb. für Min., 1857, p. 284, pl. 12, figs. 10, 11.

[b] Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 33, pl. 7, figs. 262, 263.

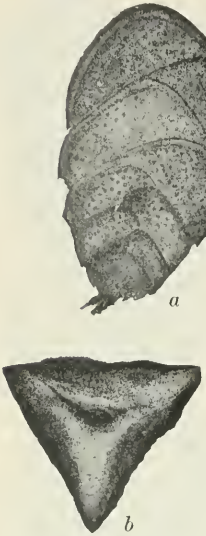


Fig. 88.—Verneuilina spinulosa. × 60. *a*, front view; *b*, apertural view.

Length 0.25–0.75 mm.

Distribution.—This species seems to be widely distributed in the North Pacific. Brady records it from four *Challenger* stations in this area, the extremes of depth being 7 and 2,300 fathoms. Rhumbler notes its occurrence at Laysan Island, and Bagg records it from five *Albatross* stations near the Hawaiian Islands in from 275 to 865 fathoms.

I have had material from a considerable number of stations in the North Pacific, all but two of which were from depths greater than 100 fathoms. Brady found that but 7 of his 24 stations for this species were in depths greater than 100 fathoms. The greatest depth at which material was taken including this species was 1,355 fathoms in the *Nero* soundings near the Hawaiian Islands. Nearly all the specimens examined were from south of 30° north.

VERNEUILINA AFFIXA, new name.

Verneuilina propinqua H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 387, pl. 47, figs. 13, 14 [not figs. 8–12].—Goës (part), Bull. Mus. Comp. Zoöl, vol. 29, 1896, p. 38.

Description.—Test affixed, pyramidal, tapering to a rather acute point at the apical end, triserial except at the attached end, which may be biserial in the attached chambers; test usually somewhat curved; wall coarsely arenaceous, but only slightly roughened on the surface; aperture at the base of the inner margin of the chamber in an elongated depression formed by the last formed whorl of chambers, rounded or somewhat elongate; color reddish brown, except the attached chambers and the area of attachment about the chambers, which are light gray.

Length up to 4 mm.

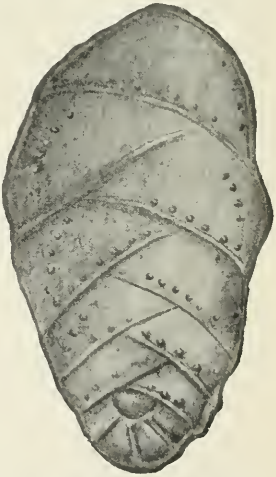
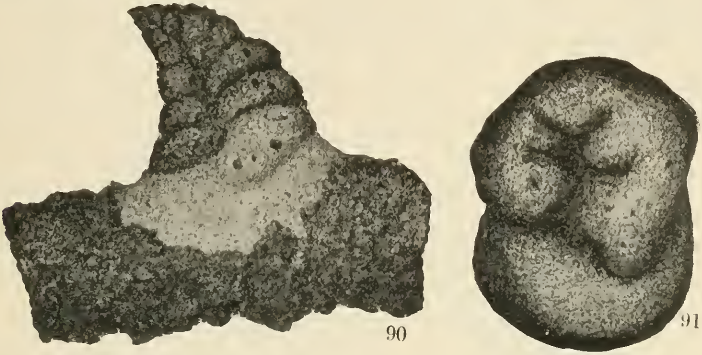


Fig. 89.—Verneuilina spinulosa (?). × 60. Specimen with coiled young.

Distribution.—As Brady includes this under *Verneuilina propinqua*, it is impossible to know at which stations this species occurred without consulting his material. Goës's specimens, one of which is figured here, were from *Albatross* station D3419, in 772 fathoms, off the west coast of Mexico, attached to tubes of *Rhabdammina irregularis* W. B. Carpenter.



FIGS. 90-91.—VERNEUILINA AFFIXA. × 25. 90, SPECIMEN ATTACHED TO RHABDAMMINA. 91, APERTURAL VIEW OF DETACHED SPECIMEN.

This species is different in every way from typical *V. propinqua* H. B. Brady. It is higher and more tapering, and is usually distinctly bent toward the tip. The chambers are more numerous and less inflated, the later with a tendency to become biserial; and it differs also in the attached habit with its consequent modifications of the apertural portion of the test.

The light gray or white border of loose material about the area of attachment appears to be common to a large number of attached forms which are not at all related.

VERNEUILINA PUSILLA Goës.

Verneuilina pusilla GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 39, pl. 5, figs. 6–8.

Description.—"Short, often nearly cylindrical, with very little inflated segments, or sometimes ovoid with inflated segments; aperture a sutural slit or an obliquely set comma-formed fissure. Pale yellow or whitish."

Length 0.50–0.66 mm.

Distribution.—This species was described by Goës from *Albatross* station D3431, in 995 fathoms, at the entrance of the Gulf of California.

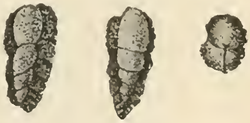


FIG. 92.—VERNEUILINA PUSILLA (AFTER GOËS).

I have carefully examined the mounted set returned to the U. S. National Museum by Goës from the above station and labeled *Verneuilina pusilla* Goës on the original label. The specimens do not fit the description or figures at all well, but many of the figures of the paper quoted are very poor when compared with the specimens. I should place these specimens under *V. polystropha* Reuss, as they seem to have all the characteristics of Brady's figures of that species.

The above description is taken from Goës.

Genus VALVULINA d'Orbigny, 1826.

Valvulina D'ORBIGNY (type, *V. triangularis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 270.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 391.

Rotalina (part) WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 55.

Description.—Test spiral, conical, with three chambers in a whorl, umbilicate, usually attached; wall arenaceous, fairly smooth; aperture provided with a valvular tooth; color usually reddish brown, area of fixation white or light gray.

The genus *Valvulina* as designated by d'Orbigny includes various fossil forms which differ somewhat in shape from our recent species but only in minor points. Typically the test is attached but it is not always found in place. The area of fixation is large.

The genus is best represented by fossil species, the recent ones being few and specimens rare.

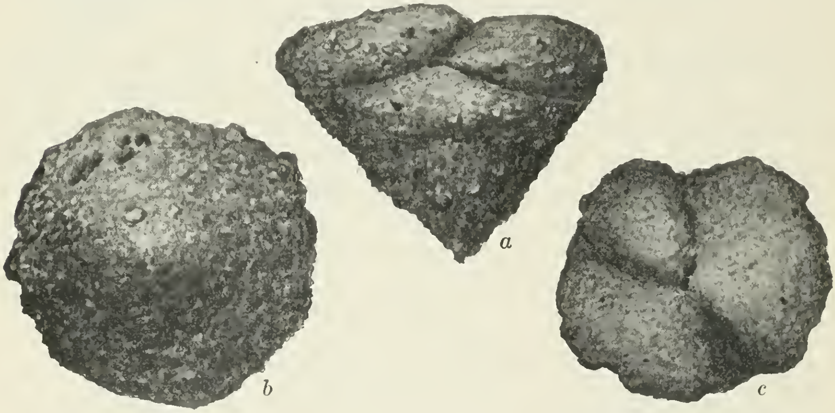


FIG. 93.—VALVULINA CONICA. × 40. *a*, FRONT VIEW; *b*, FROM ABOVE; *c*, FROM BELOW.

VALVULINA CONICA (Parker and Jones).

Valvulina triangularis PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 295, pl. 11, figs. 15, 16 (not *Valvulina triangularis* d'Orbigny).

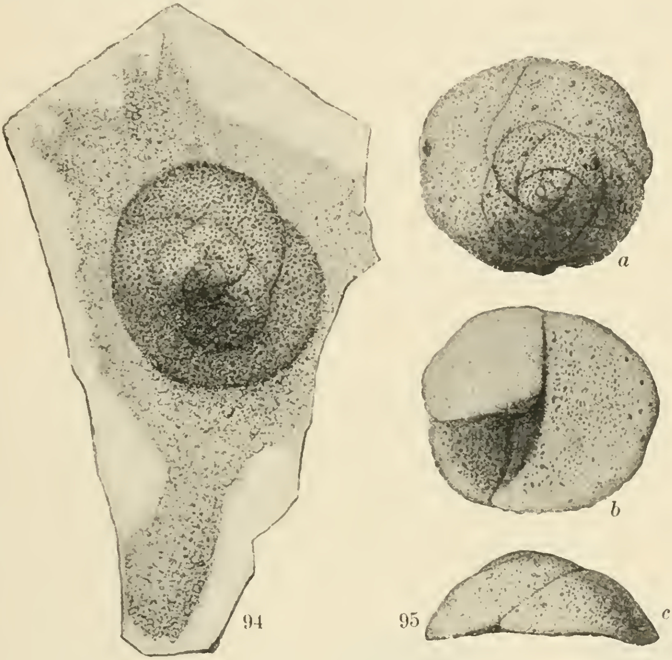
Valvulina triangularis, var. *conica* PARKER and JONES, Philos. Trans. Roy Soc., vol. 155, 1865, p. 406, pl. 15, fig. 27.

Valvulina conica M. SARS, Vid. Selsk. Forh., 1868, p. 249.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 392, pl. 49, figs. 15, 16.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 41, fig. 21; pl. 42, figs. 16, 17.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 39, pl. 8, figs. 342-352.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 286, pl. 31, fig. 3.

Description.—Test typically attached, conical, often with the axis somewhat curved, the apical end bluntly pointed, the affixed end flat and truncate, even concave; chambers arranged spirally, but so as to form a triserial test; wall coarsely arenaceous, rough or fairly smooth on the surface; aperture slit-like, at the inner basal margin of the chamber, protected by a valvular lip; early chambers dark reddish brown, the later becoming lighter; area of attachment light gray.

Diameter about 0.50 mm.

Distribution.—There are no previously published records for this species in the North Pacific. The only specimens obtained from the material examined were from *Albdtross* station H2922, in 268 fathoms, near the Hawaiian Islands.



FIGS. 94–95.—VALVULINA FUSCA. 94, ATTACHED SPECIMEN. × 40. 95, *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, SIDE VIEW. × 50 (AFTER BRADY).

VALVULINA FUSCA (Williamson).

Rotalina fusca WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 55, pl. 5, figs. 114, 115.—TERQUEM, Ess. Anim. Plage Dunkuerque, 1875, p. 26, pl. 2, figs. 6, *a*, *b*.

Valvulina fusca M. SARS, Vid. Selsk. Forh., 1868, p. 249.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 392, pl. 49, figs. 13, 14.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 39, pl. 8, figs. 353–355.

Valvulina triangularis, var. *austriaca* PARKER and JONES, Introd. Foram., 1862, p. 311.

Valvulina austriaca H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 472.

Description.—Test typically attached, low conical, depressed, rounded, the affixed end concave; chambers spirally arranged, with only three chambers in each whorl; wall finely arenaceous, smooth;

aperture slit-like, at the inner basal margin of the chamber, protected by a valvular lip; early chambers reddish brown, the later yellowish brown; area of attachment light gray.

Diameter 0.50–0.65 mm.

Distribution.—The only record for this species in the North Pacific is that given by Brady from near the Philippines, in 95 fathoms. I have not met with the species in the material which I have examined.

Genus CHRYSALIDINA d'Orbigny, 1846.

Chrysalidina D'ORBIGNY (type, *C. gradata* d'Orbigny), For. Foss. Vienne, 1846, p. 194.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 387.

Description.—Test many chambered, triserial, at least in the early portion, tapering; apertures numerous, scattered over the terminal wall of the chamber; other walls also porous.

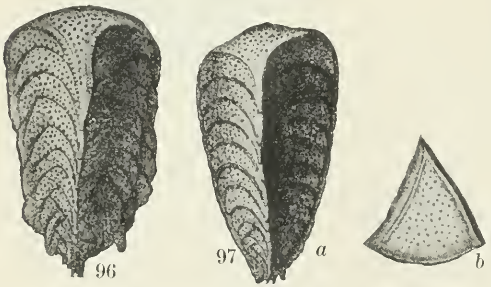
This genus includes two species, one a fossil from the cretaceous of the Vienna basin, the other a very rare recent species occurring in shallow water in the warmer portion of the Pacific and Indian Oceans.

It is rather probable that these two species are not generically related, but until more is known about them they may be considered as belonging to one genus.

CHRYSALIDINA DIMORPHA H. B. Brady.

Chrysalidina dimorpha H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 388, pl. 46, figs. 20, 21.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 274, pl. 6, figs. 47, 51, 52.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 12, pl. 1, fig. 14.

Description.—Test free, elongate, tapering, triangular in cross section, the sides nearly equal, somewhat concave, the edges slightly carinate; early portion acute, consisting of chambers arranged triserially, the later portion composed of chambers arranged in a single series; wall hyaline, perforate; apertures numerous on the broadened terminal face of the chamber.



FIGS. 96-97.—CHRYSALIDINA DIMORPHA. × 70. 97, *a*, FRONT VIEW; *b*, APERTURAL VIEW (AFTER BRADY).

Length about 0.50 mm., diameter about 0.25 mm.

Distribution.—This species is known from the warmer portions of the Pacific and Indian Oceans, almost entirely from shallow water or from shore sands. The only published North Pacific records are given by Brady: Coral reef of Honolulu, in 40 fathoms; Hongkong Harbor, in 7 fathoms.

Genus TRITAXIA Reuss, 1860.

Textularia (part) Reuss, Verst. Böhm. Kreid., pt. 1, 1845, p. 39.
Tritaxia Reuss (type, *T. tricarinata* (Reuss)=*Textularia tricarinata* Reuss), Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 228.—H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 388.

Description.—Test triserial, at least in the earlier portion, usually triangular in cross section; aperture central and terminal with or without a distinct neck and lip, rounded; wall usually arenaceous.

This genus, as defined by Reuss and employed by Brady, includes those triserial forms which in their earlier development are like *Verneuilina* and have a textularian aperture, later changing their plan of development so that the newly added chamber occupies nearly or quite the whole of the apertural end of the test. With this change in the chamber comes a change in the aperture to a terminal position and a corresponding change in shape to a circular opening, usually with a raised lip, and in some species with a definite tubular neck as well.

A new genus has been erected for *T. caperata* H. B. Brady, which is in many ways different from other species of *Tritaxia*.

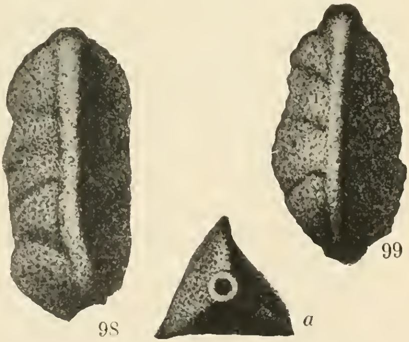
TRITAXIA TRICARINATA (Reuss).

Textularia tricarinata Reuss, Verst. Böhm. Kreid., pt. 1, 1845, p. 39, pl. 8, fig. 60.
Tritaxia tricarinata Reuss, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p, 228, pl. 12, figs. 1, 2.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 389, pl. 49, figs. 8, 9.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 39.

Description.—Test elongate, triangular in cross section, the edges carinate, the apical end bluntly rounded, the sides slightly concave; apertural aspect triangular; wall rather coarsely arenaceous, fairly smooth, the sutures rather indistinct; aperture in adult specimens rounded, central, terminal, often with a short neck; color brown.

Length about 1 mm.

Distribution.—Goës records this species as rare in the Pacific (referring to the southeastern portion of the North Pacific), in 900 fathoms. None of the Pacific stations from which Goës had material is exactly 900 fathoms in depth, although several are near it. Under the lists by stations this species does not occur from the Pacific list, and there are no specimens in the lot returned by Goës. Therefore the record rests solely upon the published work of Goës.



Figs. 98-99.—Tritaxia tricarinata. × 35. 98, *a*, apertural view (after Brady).

It is a question whether Brady was correct in assigning the recent form which occurred only off Torres Strait to the cretaceous species described by Reuss. In the absence of material this point can simply be suggested as open to question.

Genus GAUDRYINA d'Orbigny, 1839.

Gaudryina D'ORBIGNY (type, *G. rugosa* d'Orbigny), in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 109; Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 43; For. Foss. Vienne, 1846, p. 197.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 377.

Heterostomella REUSS, Sitz. Akad. Wiss. Wien, vol. 52, pt. 1, 1865, p. 448.

Description.—Test free, composed of two distinct portions, the earlier consisting of a series of chambers arranged triserially, followed by a later consisting of a series arranged biserially; wall arenaceous, varying much in coarseness in the different species; aperture variable as in the various species of *Textularia,* either an opening at the base of the inner margin of the chamber, between it and the wall of the preceding chamber, or a perforation near the base of the inner margin, often with a raised border, or in some species a terminal more or less circular opening.

This species, while related to *Textularia,* is by its development a genus derived through triserial forms, such as *Verneuilina,* and its resemblance to *Textularia* is due to a reversion in its later development to the biserial condition. There has been some attempt on the part of certain authors to split the genus on the basis of the apertural characters. While this seems reasonable, it is not followed out here, as already mentioned in connection with *Textularia.*

This genus has a considerable geological range, but after a study of certain forms it has not seemed wise to unite the recent species with the cretaceous ones described by d'Orbigny. The differences are great enough to be of good specific value, and a discussion of the characters involved will be found under the various species. Most of the recent species are rather constant in their characters, the variations being limited to unimportant details.

GAUDRYINA SCABRA H. B. Brady.

Gaudryina pupoides H. B. BRADY (not *G. pupoides* d'Orbigny 1840), Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 300, pl. 8, fig. 5.

Gaudryina scabra H. B. BRADY, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 381, pl. 46, fig. 7.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 40.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 288, pl. 34, fig. 1.

Description.—Test elongate, gradually tapering to the initial end, which is broadly rounded; cross section rounded; early triserial portion composed of but few chambers, the later biserial portion forming the greater part of the test, chambers rotund; sutures distinct; wall coarsely arenaceous, but rather neatly cemented with a reddish-brown cement; aperture elongate, situated between the inner border of the chamber and the adjacent wall of the preceding chamber; color reddish-brown, the last formed chamber often being light gray.

Length up to 2 mm.

Distribution.—The only published records for this species in the North Pacific are those given by Goës from off the west coast of America, *Albatross* stations D3419, in 772 fathoms, D3431, in 995 fathoms, and D3418, in 660 fathoms. I have examined the specimens of this species returned by Goës to the National Museum and they appear to be typical. In the further material I have examined the species has been noted but twice, from *Albatross* station H2922, in 268 fathoms, off the Hawaiian Islands and from *Tuscarora* station 126, in 500 fathoms, just south of the Aleutian Islands.

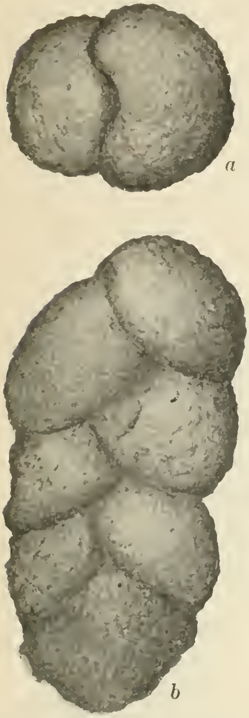


FIG. 100.—GAUDRYINA SCABRA. × 45. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

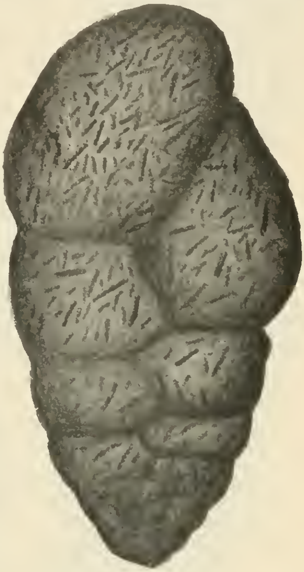


FIG. 101.—GAUDRYINA SCABRA. × 30 SPECIMEN WITH WALL CONTAINING SPONGE SPICULES.

GAUDRYINA FLINTII, new name.

Gaudryina subrotundata FLINT (not *G. subrotundata* Schwager, 1866), Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 287, pl. 33, fig. 1.

Gaudryina rugosa GOËS (not *G. rugosa* d'Orbigny, 1840), Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 39.

Description.—Test subcylindrical, gradually tapering to the initial end, the early triserial portion forming but a small part of the test, the later biserial portion making up fully three-fourths; chambers of the later portion well rounded, nearly circular in cross section; sutures well marked; wall arenaceous, usually rather coarse, but in some cases finer and more smoothly finished; aperture in the biserial portion a subcircular opening near, but somewhat away from, the inner border of the chamber; color gray.

Length 1–5 mm.

Distribution.—The specimens recorded by Flint and figured by him as *G. subrotundata* Schwager were from the Atlantic. The specimens recorded by Goës from the eastern Pacific as *G. rugosa* d'Orbigny, prove upon examination to belong to this new species. Specimens were also common in material from *Nero* station 990, in 859 fathoms, off Guam.

It is possible that the *Challenger* specimens referred to *G. subrotundata* by Brady may also belong to this species, especially those from the West Indies. The specimens recorded by Goës seem to be neither the *G. rugosa* of d'Orbigny nor the recent species referred to *G. rugosa* by Brady. This species differs from *G. subrotundata* in the large size, more circular form in cross section, in the general tapering form, and in having the aperture circular and in the end wall.

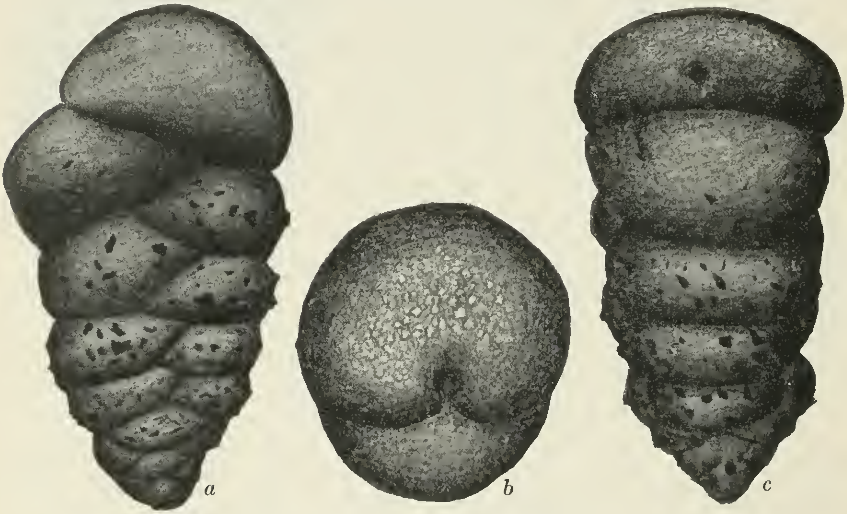


FIG. 102.—GAUDRYINA FLINTII. × 20. *a*, FRONT VIEW; *b*, APERTURAL VIEW; *c*, SIDE VIEW.

GAUDRYINA QUADRANGULARIS Bagg.

Gaudryina quadrangularis BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 133, pl. 5, fig. 1.

Description.—Test elongate, tapering abruptly at the initial end, composed of an early trihedral portion with acute angles made up of a triserial group of chambers, and a later more or less quadrangular portion composed of chambers biserially arranged; wall coarsely arenaceous and rather roughly cemented; aperture an elongate orifice between the inner border of the chamber and the adjacent wall of the preceding chamber, with in end view a sort of rounded lip above and a depression at either side; in side view the aperture is in a depression of the abruptly truncated end of the test.

Length up to 3 mm.

Distribution.—The type-specimen (which I have examined) is from *Albatross* station D4000, in 104–213 fathoms, off the Hawaiian Islands. The only other specimens I have seen were obtained at *Nero* station 2071, in 271 fathoms, and *Albatross* station H2922, in 268 fathoms, also near the Hawaiian Islands.

The species is a large one, with a distinctly textularian aperture.

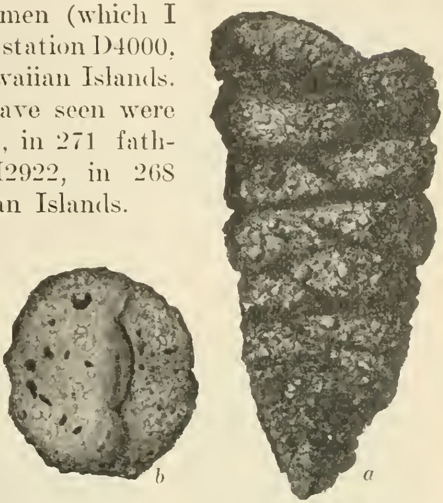


FIG. 103.—GAUDRYINA QUADRANGULARIS. × 30. *a*, FRONT VIEW; *b*, END VIEW.

GAUDRYINA TRIANGULARIS, new species.

Description.—Test slightly longer than broad, for the most part triangular, the angles rather acute, composed of a series of chambers triserially arranged, the later chambers rotund, biserially arranged, few in number; walls coarsely arenaceous, more or less smoothly finished; sutures plainly visible on the exterior; aperture narrow, between the inner border of the chamber and the preceding chamber; color gray.

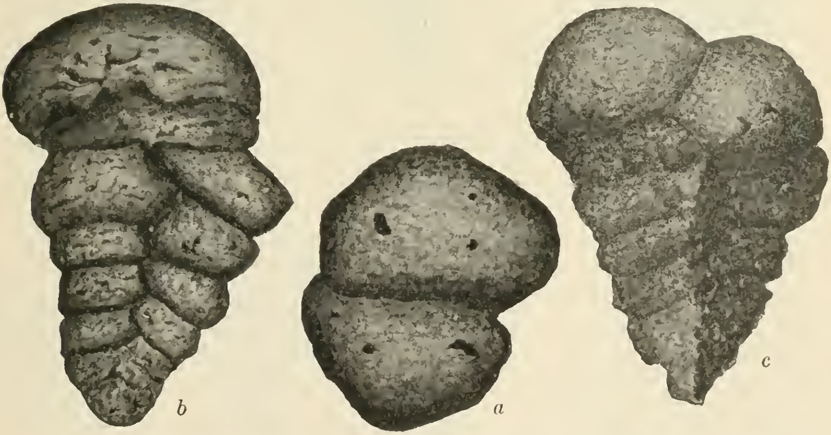


FIG. 104.—GAUDRYINA TRIANGULARIS. × 40. *a*, END VIEW; *b*, SIDE VIEW; *c*, FRONT VIEW.

Length about 1 mm.

Distribution.—Type-specimen from *Albatross* station H2922, in 268 fathoms, near the Hawaiian Islands (Cat. No. 8342, U.S.N.M.).

It occurred also at *Nero* station 1254, in 264 fathoms, near the Bonin Islands in the western Pacific.

This species may be the same as that from the Atlantic referred by various authors to *G. rugosa* d'Orbigny. A glance at the original figure given by d'Orbigny, however, shows the great difference between this recent species and d'Orbigny's cretaceous fossil species. In true *G. rugosa*, according to d'Orbigny's figure and description, the triangular portion is the smaller part, and the biserial portion the greater, the whole appearance of the test being very different. Here the triserial condition is maintained well toward the end of the test, where the biserial condition is taken on. Our recent species seems to me to have little in common with the cretaceous species.

GAUDRYINA CONVEXA, new species.

Description.—Test triangular in front view, broad at the apertural and rather rapidly tapering to the initial end, one face nearly flat, the other strongly convex and with deeper sutures; apertural end obliquely truncate, in end view roughly semicircular; wall rather coarsely arenaceous; aperture elongate, between the inner border of the chamber and the adjacent wall of the preceding chamber, in a distinct depression of the inner border of the chamber; color gray.

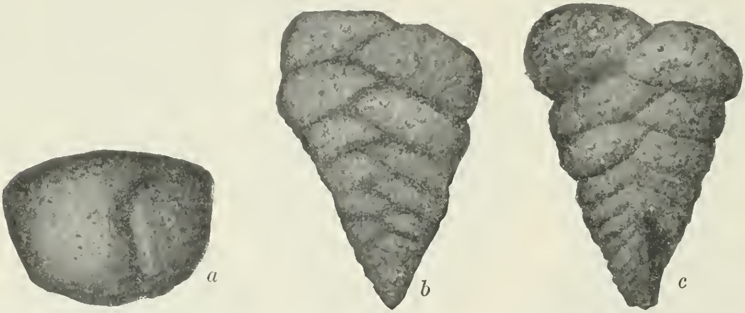


FIG. 105.—GAUDRYINA CONVEXA. × 60. *a*, END VIEW; *b*, DORSAL VIEW; *c*, VENTRAL VIEW.

Length 0.60 mm.

Distribution.—Type from *Albatross* station D4878, in 59 fathoms, eastern channel of the Korean Strait (Cat. No. 8343, U.S.N.M.).

This species suggests somewhat *G. wrightiana* Millett, but both faces in our species in the biserial portion are convex, one of them, however, only slightly so. It also somewhat resembles *G. jonesiana* Wright.

GAUDRYINA PAUPERCULA, new species.

Description.—Test short and broad, abruptly tapering to the broadly rounded initial end, the early portion triserial, the last developed chambers biserial; chambers inflated; sutures distinct; end view broadly rounded; walls arenaceous, but with a smooth exterior; aperture elongate, situated in a depression of the inner border of the chamber, between it and the adjacent wall of the preceding chamber; color gray or slightly brownish.

Length 2 mm.

Distribution.—This species was very abundant in material from *Albatross* station D4900, in 139 fathoms, Eastern Sea (type, Cat. No. 8340, U.S.N.M.).

This species seems at first glance to be very similar to *Verneuilina propinqua* H. B. Brady, but it is a *Gaudryina*, as the last formed chambers are decidedly biserial. It is a very short species and differs in general appearance from the others of its genus.

GAUDRYINA BRADYI, new name.

Gaudryina pupoides H. B. Brady (not *G. pupoides* d'Orbigny), Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 378, pl. 46, figs. 1–4.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 43, figs. 7, 8.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.—Chapman, Proc. Zool. Soc. London, 1895, p. 20.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 40.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 287, pl. 32, fig. 4.

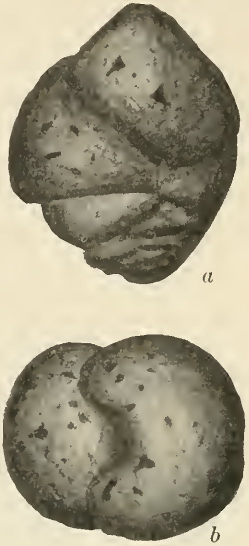


Fig. 106.—Gaudryina paupercula. × 15. *a*, front view; *b*, apertural view.

Description.—Test stout, somewhat elongate, tapering slightly until near the initial end where it tapers abruptly to the somewhat blunt end; triserial portion nearly circular in cross section, of few chambers, the later biserial portion making up about three-fourths of the test, slightly compressed; chambers overlapping and appearing crowded, broadly elliptical in cross section, inflated; sutures deep and distinct; end strongly convex; wall of fine arenaceous material or calcareous shell, smooth; aperture oval, slightly back from the inner margin of the chamber and with the border raised somewhat and thickened; color light gray.

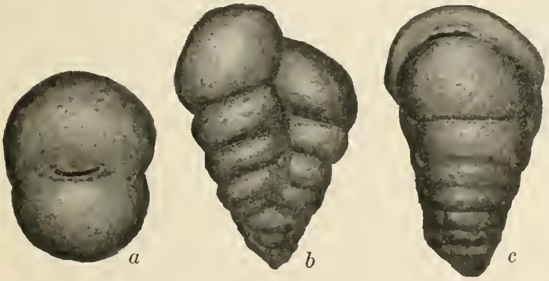


Fig. 107.—Gaudryina bradyi. × 25. *a*, end view; *b*, front view; *c*, side view.

Length 0.38 to 0.90 mm.

Distribution.—Under the name of *Gaudryina pupoides* this species has been recorded as follows from the North Pacific: Brady records it at two *Challenger* stations in 1,850 and 2,050 fathoms; Goës records it from two *Albatross* stations, D3375, in 1,201 fathoms, and D3376, in 1,132 fathoms; Bagg records it from four *Albatross* stations near the Hawaiian Islands, H4430, in 1,544 fathoms, H4555, in 1,398 fathoms, H4568, in 1,274 fathoms, and H4571, in 384 fathoms; Flint records it[a] from *Nero* station 613, in 1,072 fathoms.

In the material I have examined, the species has been frequently found in the vicinity of the Hawaiian and Galapagos Islands, Guam, off Japan, etc. The average depth of the stations is about 1,000 fathoms.

From an examination of the original figure and description given by d'Orbigny, it seems clear that our rather common recent form is not the same as his cretaceous species. Goës came to the conclusion that Brady's union of the two was incorrect. However, to unite both this species and *G. chilostoma* as Goës has done, both under the latter name, does not seem to me to be a solution of the matter, as the two seem to be very distinct. As no other name is available, a new name is here proposed. This is one of the cases where it would seem to have been better if Brady had proposed a new name instead of uniting different things, as the *Challenger* Report has been looked to so long as a standard that Brady's distinctions in regard to original figures and descriptions have not always been investigated by later authors. A new name at that time and a recognition of the existing differences would have cleared the synonymy greatly.

GAUDRYINA BACCATA Schwager.

Gaudryina baccata Schwager, *Novara* Exp., Geol. Theil, p. 2, 1866, p. 200, pl. 4, figs. 12*a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 379, pl. 46, figs. 8-11.—Chapman, Proc. Zool. Soc. London, 1895, p. 20.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 287, pl. 32, fig. 5.

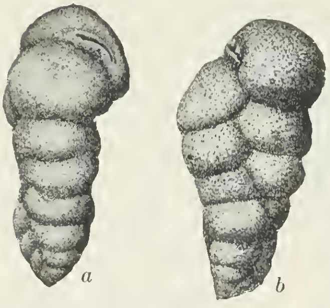


Fig. 108.—Gaudryina baccata. × 20. *a*, side view; *b*, front view (after Brady).

Description.—Test elongate, tapering gradually to the somewhat acute initial end; early portion composed of triserially arranged chambers with rounded angles and forming the lesser portion of the test; later portion biserial, often somewhat irregular; wall arenaceous, of fine material and smoothly finished; aperture elongate, somewhat back from the inner border of the chamber and often with a raised border; color gray.

Length about 2 mm.

Distribution.—The only records for this species in the North Pacific are the specimens recorded by Brady from *Challenger* station 206, in 2,100 fathoms, between China and the Philippines.

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[a] Bull. 55, U. S. Nat. Mus., 1905, p. 20.

This species is characterized by an irregular form in the biserial portion, one or more of the chambers breaking the alignment somewhat and causing the following to be less regular than they would be otherwise.

GAUDRYINA CHILOSTOMA (Reuss).

Textilaria chilostoma REUSS, Zeitschr. deutsch. geol. Ges., vol. 4, 1852, p. 18.

Gaudryina chilostoma REUSS, Denkschr. Akad. Wiss. Wien, vol. 25, 1866, p. 120, pl. 1, fig. 5.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 34, pl. 7, figs. 278–280; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 41.

Gaudryina pupoides, var. *chilostoma* H. B. BRADY, Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 379, pl. 46, figs. 5, 6.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 42, fig. 9.

Gaudryina pupoides, var. *chilostomella* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 278, pl. 7, fig. 6 [?].

Description.—Test compressed, broad, gradually tapering to the broadly rounded initial end; triserial portion consisting of but few chambers; biserial portion compressed, making up most of the test; chambers rounded; wall of fine arenaceous material; the surface smoothly finished; aperture an elongate slit slightly in from the inner edge of the chamber, surrounded by a slightly thickened and raised lip; color gray.

Length about 1 mm.

Distribution.—Goës records this species from *Albatross* station D3407, in 885 fathoms, off the Galapagos Islands. One at least of the two specimens selected by Goës from this station appears to be this species upon examination. Egger's figure and description are apparently meant for this species, but do not fit it very closely. I have seen but one specimen which I can refer to this species, from the coast of Japan, *Albatross* station D4916, in 361 fathoms.

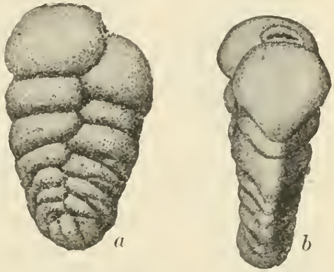

FIG. 109.—GAUDRYINA CHILOSTOMA. × 25. *a*, FRONT VIEW; *b*, SIDE VIEW (AFTER BRADY).

GAUDRYINA APICULARIS, new name.

Gaudryina siphonella H. B. BRADY (not *G. siphonella* Reuss, 1851), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 382, pl. 46, figs. 17–19.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 288, pl. 34, fig. 2.

Description.—Test elongate; triserial portion consisting of few chambers, forming usually somewhat less than half the test; later portion biserial, the chambers inflated and distinct, the later chambers with a forward extension, at the end of which is the aperture; wall rather coarsely arenaceous and slightly rough; aperture nearly circular, at the end of the elongate chamber; color reddish brown.

Length up to 1 mm.

Distribution.—As *G. siphonella*, Brady has recorded this species from three *Challenger* stations in the North Pacific, in from 2,100–3,950 fathoms. I have noted the species but once, in 2,141 fathoms, *Nero* station 1293, between Yokohama and Guam.

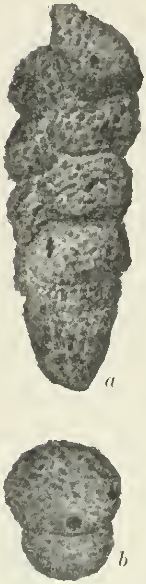

FIG. 110.—GAUDRYINA APICULARIS. × 60. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

An examination of the original description of *Gaudryina siphonella* Reuss,[a] and especially the figures, shows that the recent species described here is very different from that fossil. Fig. 42 of Reuss shows a test with five vertical rows of chambers, and need not be further considered here. Of the others, each has the final chamber very convex and extending much higher on the outer side than on any other part, and the aperture at the end of a small, much lower projection. This curious form occurs in both figs. 40 and 41 and is noted in the description. The recent species is very different, the apertural portion forming the highest part of the chamber, which on its peripheral portion is lower than elsewhere, while the fossil species is highest there.

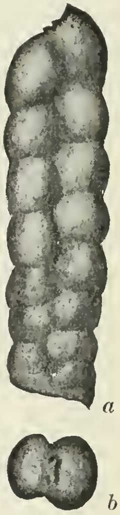

FIG. 111.—GAUDRYINA PSEUDOFILIFORMIS. × 60. *a*, FRONT VIEW; *b*, END VIEW, SHOWING OUTLINE AND RIDGE ABOVE THE APERTURE.

GAUDRYINA PSEUDOFILIFORMIS, new name.

Gaudryina filiformis H. B. BRADY (not *G. filiformis* Berthelin), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 380, pl. 46, figs. 12*a–c*.

Description.—Test much elongate, composed of numerous chambers; early portion triserial with indistinct sutures; later portion, including nearly the entire test, biserial with the sutures deep and well marked; cross section elliptical, showing some compression; walls arenaceous, but usually smooth; aperture small, in adults back a little way from the inner margin of the chamber, slightly elongate, the edges thickened and raised to form a rim about it, appearing nearly tooth-like in end view; color gray.

Length 1 mm.

Distribution.—*G. filiformis* has been recorded from the North Pacific only once, by Bagg, at *Albatross* station H4568, in 1,274 fathoms, off the Hawaiian Islands. I have the species also from *Albatross* station H2923, in 392 fathoms, off the same islands. These are the only records for the species in this area.

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[a] Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 78, pl. 5, figs. 40–42.

Although Brady referred the recent species to the cretaceous *G. filiformis,* it seems from a comparison of the material obtained with the original description and figure, that the two species are not the same, and the recent species is therefore differentiated under another name. It is smooth and has the aperture somewhat in from the edge, surrounded by a raised ridge.

TRITAXILINA, new genus.

Clavulina (part) H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54.
Tritaxia (part) H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 390.

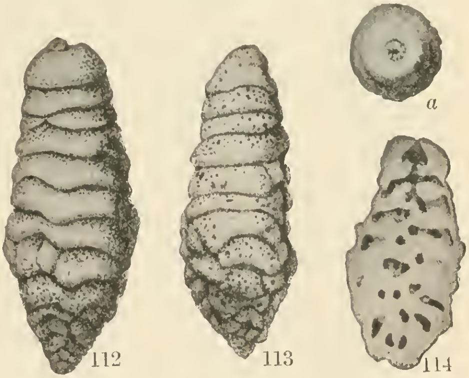
Description.—Test in the early portion triserial, later becoming biserial or uniserial; wall arenaceous; aperture in the adult, central and terminal, in the young like *Textularia* or *Verneuilina,* in adult condition with peripheral teeth projecting into the apertural opening; interior labyrinthic.

This genus includes a single species, *T. caperata* (H. B. Brady), which differs from the species of *Tritaxia* in the form of the test, the aperture, and the labyrinthic interior of the test.

TRITAXILINA CAPERATA (H. B. Brady).

Clavulina caperata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54.
Tritaxia caperata H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 390, pl. 49, figs. 1-7.

Description.—Test fusiform, the early portion triserial, roughly triangular in cross section but with well rounded angles, the later portion becoming biserial or uniserial and circular in cross section; apical end rather acutely pointed; apertural end truncate or broadly rounded, chambers numerous; wall thick, composed of fine arenaceous material, in part traversed by long pore canals leading from the chamber to the exterior; interior of test labyrinthic; outer part of wall with a wrinkled appearance due to the thickening of the chamber wall just above the sutures; sutures distinct; aperture in the young like *Verneuilina,* in the adult becoming terminal and central with a peripheral border of inwardly projecting teeth; color gray.



Figs. 112-114.—Tritaxilina caperata. × 16. 112, *a,* apertural view. 114, specimen cut longitudinally, showing labyrinthic interior (after Brady).

Length up to 2.5 mm.

Distribution.—Brady records this species from but one North Pacific station, in 95 fathoms, near the Philippines. The other stations from which he records it are off Kandavu, Fiji, in 250 fathoms, and off Sombrero, West Indies, in 450 fathoms.

There are two specimens in the *Albatross* material from station D4781, in 482 fathoms, near the Aleutian Islands, which certainly seem to be this species. If this is the case the distribution is a very peculiar one. Except that the final stages are not entirely complete, the two specimens fit the figure and description excellently.

Genus CLAVULINA d'Orbigny, 1826.

Clavulina d'Orbigny (type, *C. parisiensis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 268.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 393.

Verneuilina (part) Parker and Jones, Quart. Journ. Geol. Sci., vol. 16, 1860, p. 303.—Broeck, Ann. Soc. Belgique Micr., vol. 2, 1876, p. 136.

Valvulina (part) Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 35.

Description.—Test free, elongate, cylindrical, or angled; early portion consisting of a number of chambers arranged triserially; later portion consisting of numerous chambers arranged uniserially; walls arenaceous, usually smooth; aperture in early chambers with a valvular tooth; in the later portion aperture central or nearly so, rounded, and with or without a tooth.

This genus includes those species of Textulariidæ which have a triserial early portion and the adult portion uniserial. Such species are clearly related to such forms as *Valvulina* and have added to the characters of that genus the uniserial condition. By acceleration of development the triserial stage has become very short in comparison to the entire test and is only seen at the beginning of the development; the uniserial stage has come to occupy most of the test. The genus is known in the Tertiary and from that period to the recent seas.

There are a few widely scattered species, for the most part best developed about the shores of oceanic tropical islands, such as the West Indies. Other species are characteristic of rather deep water and are widely distributed.

CLAVULINA COMMUNIS d'Orbigny.

Clavulina communis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 268; For. Foss. Vienne, 1846, p. 196, pl. 12, figs. 1,2.—Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 394, pl. 48, figs. 1-13.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 220, pl. 42, fig. 11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 275, pl. 6, figs. 42, 43.—Goës, Kong. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 40; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 36, pl. 4, figs. 9-15.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 288, pl. 34, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1900, p. 12.—Chapman, Journ. Linn. Soc. New South Wales, vol. 30, 1907, p. 29, pl. 3, fig. 66.

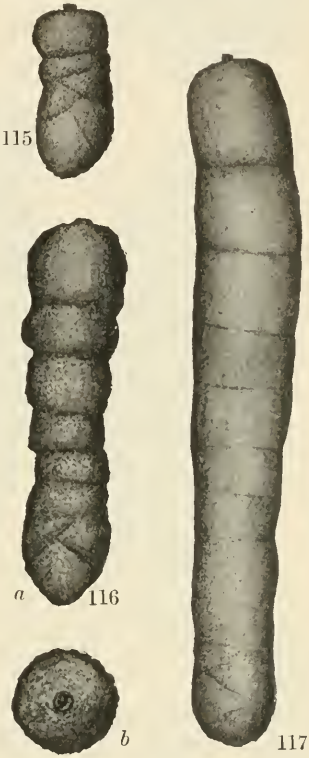
Verneulina communis Jones and Parker, Quart. Jour. Geol. Soc., vol. 16, 1860, p. 303.—Broeck, Ann. Soc. Belgique Micr., vol. 2, 1876, p. 136, pl. 3, fig. 14.

Description.—Test elongate, cylindrical, the early portion consisting of chambers arranged triserially, rounded in cross section; chambers almost indistinct from the exterior, the sutures not depressed; later portion consisting of chambers arranged uniserially, distinct, but the sutures only slightly excavated, circular in cross section; wall composed of sand, usually fine in texture, with the surface smoothly finished; aperture in the middle of the terminal wall of the chamber in the uniserial portion, usually with a short but very distinct neck; aperture with a single tooth; color gray.

Length up to 5 mm.

Distribution.—In the North Pacific this species was recorded by Brady from two *Challenger* stations, in 345 fathoms off Japan, and in 2,300 fathoms in the region east of Japan; Goës records it from several *Albatross* stations off the west coast of America in depths from 772–1,471 fathoms; Flint records it from 51 fathoms in Panama Bay. I have found it frequently in the North Pacific material which I have examined, most frequently in globigerina ooze and muds from a medium depth. It has occurred near the Galapagos Islands, and at scattered stations in the *Nero* material from the line of soundings across the Pacific, and in the material from the *Albatross* (1906) cruise it is common from about Japan. It occurs also in the collections from south of the Aleutian Islands, Tuscarora station 126, in 500 fathoms.

This, as far as the North Pacific is concerned, is by far the most common species. As shown by Brady's figures in the *Challenger* report, there are two rather different forms, but the material is not sufficient to establish definite varieties at this time.



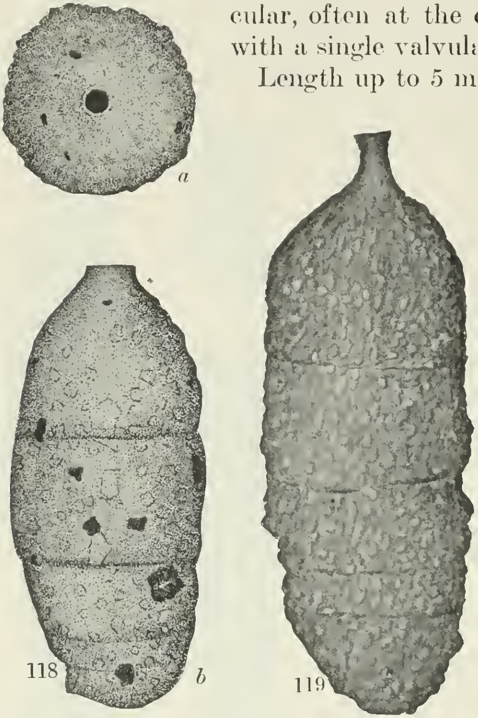
FIGS. 115-117.—CLAVULINA COMMUNIS. × 30. 115, YOUNG SPECIMEN WITH BUT TWO OF THE SECOND SERIES OF CHAMBERS DEVELOPED. 116, *a*, FRONT VIEW OF MEDIUM-SIZED SPECIMEN; *b*, END VIEW OF THE SAME. 117, ADULT SPECIMEN IN FRONT VIEW.

CLAVULINA BRADYI, new name.

Clavulina cylindrica H. B. BRADY (not *C. cylindrica* d'Orbigny, 1826), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 396, pl. 48, figs. 32–38.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 134.

Description.—Test stout, cylindrical, the early triserial portion not well shown exteriorly, the later uniserial portion of few chambers, large, distinct, with well-defined, depressed sutures; wall arenaceous, composed of a mixture of coarse and fine material, but usually with a smooth exterior; aperture circular, often at the end of a short neck, usually with a single valvular tooth; color light gray.

Length up to 5 mm.



Figs. 118-119.—Clavulina bradyi. × 30. 118, *a*, end view, without tooth; *b*, front view of typical specimen. 119, front view of a peculiarly roughened specimen.

Distribution.—The only previously recorded station for this species is that given by Bagg: *Albatross* station D4000 in 104-213 fathoms, off the Hawaiian Islands. I have seen the species in material from *Nero* station 2037, in 55 fathoms, and 2071, in 271 fathoms, both in the vicinity of the Hawaiian Islands.

There is much exterior resemblance between this species and *Haplostiche dubia*, but the specimens of *Clavulina bradyi* having the single valvular tooth or sometimes none. Fig. 119 shows a specimen somewhat different from the usual form shown in fig. 118. It has a more distinctly roughened surface and a longer and more slender neck, but is associated with the species at the same station.

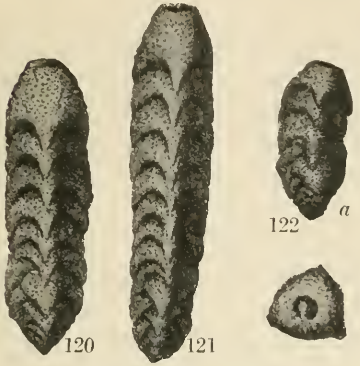
CLAVULINA ANGULARIS d'Orbigny.

Clavulina angularis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 268, pl. 12, fig. 7.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 396, pl. 48, figs. 22-24.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 37.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 289, pl. 36, fig. 2.—Millett, Journ. Roy. Micr. Soc., 1900, p. 13.—Chapman, Journ. Linn. Soc., Zool., vol. 30, 1907, p. 29, pl. 4, figs. 68, 69 [70], [not 71-73].—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 133.

Valvulina angularis Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 305.

Valvulina triangularis d'Orbigny, forma *clavulina* Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, p. 86, pl. 11, figs. 387-389.

Description.—Test elongate, triangular in cross section, the early triserial portion limited to a few chambers, followed by a few chambers biserial in character; finally the main portion of the test, which is uniserial, the chambers extending back along the angles of the test, arched upward across the faces, leaving a slight hollow below; wall arenaceous but smoothly finished on the exterior; aperture in the uniserial portion circular, in the middle of the apertural face, with a single valvular tooth.



120–122.—Clavulina angularis × 35. 122, *a*, front view; *b*, apertural view (after Brady).

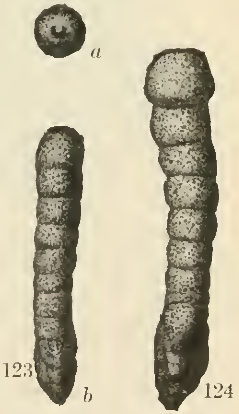
Length up to 1.25 mm.

Distribution.—There is but one record for this species in the North Pacific, that given by Bagg, from *Albatross* station D4017, in 305 fathoms, off the Hawaiian Islands. I have examined Bagg's specimen and it seems without doubt to be this species, although the test is not entire. It has been found in various parts of the other oceans, usually in rather shallow water.

CLAVULINA PARISIENSIS d'Orbigny.

Clavulina parisiensis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 268; Modèles, 1826, No. 66.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 1, fig. 26.—Terquem, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 121, pl. 12 (20), figs. 34*a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 395, pl. 48, figs. 14–18.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 220, pl. 42, figs. 10, 12.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1889, p. 485, pl. 11, fig. 11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 274, pl. 6, fig. 44.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 41, pl. 8, figs. 378–386.—Chapman, Proc. Zool. Soc. London, 1895, p. 21.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 37.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 289, pl. 35, figs. 2, 3.

Valvulina parisiensis Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, pp. 29, 35, pl. 1, fig. 26.



Figs. 123–124.—Clavulina parisiensis. × 30. 123, *a*, apertural view; *b*, front view (after Brady).

Description.—Test elongate, slender, the early triserial portion decidedly angled, pyramidal, the upper end usually wider than the early part of the following uniserial portion which is cylindrical; chambers of this portion inflated, often well separated by deep sutures, sometimes moniliform; walls arenaceous, usually rather coarsely so, and the exterior more or less rough; aperture in the uniserial portion circular, central, partially closed with a broad valvular tooth.

Length up to 3 mm.

Distribution.—The only published records for this species from the North Pacific are those given by Brady from two *Challenger* stations, one off the Philippines, in 95 fathoms, the other in the deep water of the Pacific, in 3,125 fathoms. This latter seems all the more peculiar, as the species as a rule has been found in comparatively shallow water.

Subfamily 4. BULIMININÆ.

Included in this subfamily are those forms which are typified by *Bulimina*. In typical species the arrangement of the chambers is an elongate spiral. The aperture is elongate, loop-shaped, usually in an oblique position, and in some species there is a tooth, flange, or other structure which partially closes the opening. The test is calcareous, often hyaline in the young, but may be considerably thickened and opaque in the adult; is always perforate.

Two new genera have been segregated from *Bulimina*, the differences in structure and development appearing to be worthy of more than specific rank.

Genus BULIMINA d'Orbigny, 1826.

Bulimina D'ORBIGNY (type, *Bulimina marginata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 269.—H. B BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 397.

Description.—Test usually fusiform or tapering, free, composed of numerous chambers arranged typically in a spiral, each chamber situated above the third preceding one, making a triserial arrangement, not always visible from the surface except in the last convolution; wall calcareous, perforate, usually thin and transparent but thickening somewhat with age; smooth or ornamented with raised costæ, spines, etc.; aperture typically a comma-shaped slit broadest above and tapering obliquely to a point below, usually with a raised rim and often partly closed by a tooth-like rim at one side.

The genus *Bulimina* as it has come to be used includes several distinct groups of species as noted by Brady in the *Challenger* report upon the Foraminifera. If these groups are closely examined it will be noted that their differences are really morphological and essential characters, too distinct to be accounted for on the basis of variation and seem to be of generic significance. I have therefore divided the genus into several genera which show distinctive characters, and have limited the name *Bulimina* to those species which show a triserial arrangement of the chambers. Such an arrangement is seen in the typical *Bulimina marginata*, the only species figured by d'Orbigny of those given under the genus in the original description.

The groups of species which have numerous chambers in each coil and a definite umbilicus, with other accompanying characteristics, are grouped under the new genus *Buliminella*, and the single species *Bulimina williamsonii* H. B. Brady, which has the chambers hidden at the surface by the ornamentation, but nevertheless spiral, and the aperture central and terminal, has been made the type of the new genus *Buliminoides*.

There is a considerable range of species characters in the species of *Bulimina* as restricted, the chambers in certain forms becoming rapidly larger, and in the adult hiding the earlier or becoming larger with an accompanying extension of the axis of the spire forming a long tapering test with the triserial arrangement visible throughout.

From the difficulty of examining the proloculum and early chambers, little is known concerning the occurrence of the microspheric and megalospheric forms in the species of this genus.

BULIMINA OVATA d'Orbigny.

Bulimina ovata d'Orbigny, For. Foss. Vienne, 1846, p. 185, pl. ii, figs. 13, 14.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 400, pl. 50, figs. 13*a*, *b*.

Description.—Test ovate in front view, circular or nearly so in end view, the apex broadly rounded; visible chambers several, little inflated; sutures but slightly compressed; wall smooth; aperture rather narrow with a plate-like tooth; color white.

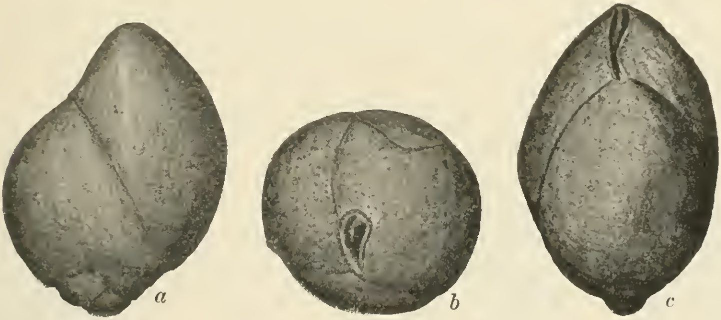


Fig. 125.—Bulimina ovata. × 40. *a*, front view; *b*, end view; *c*, view showing aperture.

Length 0.75–1.20 mm.

Distribution.—Rather common throughout the area, except in very deep water.

The smooth species of *Bulimina* are in an extremely confused state, and as the material I have examined is insufficient to determine definitely the interrelationships of all the forms, they are referred to certain general species, usually taking the figures given by Brady as a broad basis for distinguishing the forms.

Brady's figure of *Bulimina ovata* is referred by Goës to *B. ellipsoides* Costa.

BULIMINA PYRULA d'Orbigny.

Bulimina pyrula D'ORBIGNY, For. Foss. Vienne, 1846, p. 184, pl. 11, figs. 9, 10.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 399, pl. 50, figs. 7–10.

Description.—Test ovate in front view, broadest usually near the base, nearly circular in end view, the apex rounded; visible chambers few, very little inflated; sutures flush with the surface or very slightly depressed; wall smooth; aperture short and broad with a broad plate-like tooth partially closing the opening; color white.

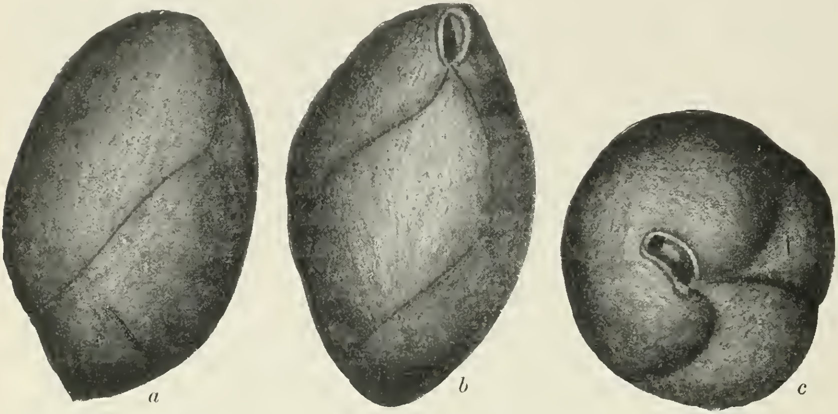


FIG. 126.—BULIMINA PYRULA. × 60. *a*, SIDE VIEW; *b*, VIEW SHOWING APERTURE; *c*, END VIEW.

Length 0.50–0.85 mm.

Distribution.—Strangely enough all the material which I have selected as belonging to this form has come from the coast of Japan, in from 134 to 437 fathoms.

This species has fewer visible chambers with a broader and shorter aperture than the preceding. The details of the aperture are shown in the enlarged figure.

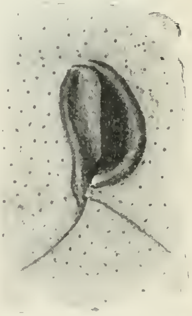


FIG. 127.—BULIMINA PYRULA. × 75. DETAILS OF THE APERTURE.

BULIMINA PYRULA d'Orbigny, var. SPINESCENS H. B. Brady.

Bulimina pyrula D'ORBIGNY, var. *spinescens* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 400, pl. 50, figs. 11, 12.

Description.—Similar to the typical form of the species but with the broad apical end of the test beset with short spines.

Distribution.—Specimens were found at *Albatross* station D4972, in 440 fathoms, off Japan. All have the same spinose apex.

The specimens figured here are much more elongate and of somewhat different form from those figured by Brady, but they have a similar spinose apex.

BULIMINA AFFINIS d'Orbigny.

Bulimina affinis d'Orbigny, Foram. Cuba, 1839, p. 109, pl. 2, figs. 25, 26.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 400, pl. 50, fig. 14*a*, *b*.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 743, pl. 16, fig. 1.—Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 554, pl. 8, fig. 23.—Chapman, Journ. Roy. Micr. Soc., 1892, p. 756, pl. 12, fig. 10.—Egger, Abh. kön. bay. Acad. Wiss. München, Cl. ii, vol. 18, 1893, p. 285, pl. 8, fig. 71.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 290, pl. 37, fig. 2.—Millett, Journ. Roy. Micr. Soc., 1900, p. 274.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 134.

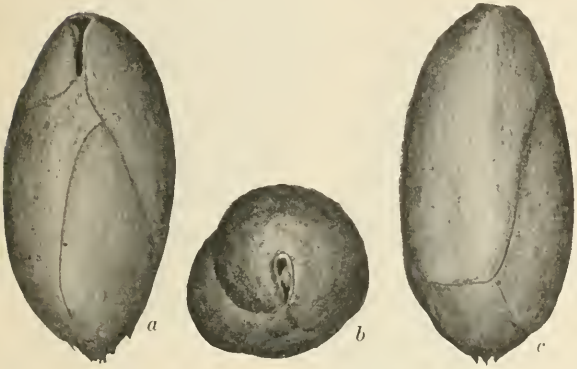


Fig. 128.—Bulimina pyrula, var. spinescens. × 80. *a*, front view; *b*, end view; *c*, side view.

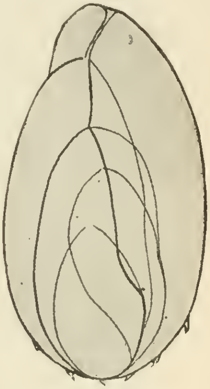


Fig. 129.—Bulimina pyrula, var. spinescens. × 175. Young specimen, outlines of first five chambers.

Description.—Test conical, tapering from the broadly rounded apertural end to the acutely pointed apical end; chambers numerous, inflated; sutures somewhat depressed; wall calcareous, smooth; aperture loop-shaped, rather short; color white.

Length about 0.75 mm.

Distribution.—Brady records this species from one station in the deeper part of the North Pacific, in 3,125 fathoms, and Bagg records its occurrence at three *Albatross* stations, D4017, D4025, and D4174, in 305–865 fathoms, off the Hawaiian Islands. I have not noted specimens which could be determined as this species.

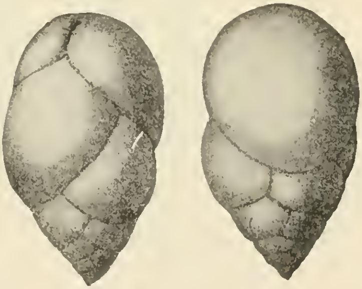


Fig. 130.—Bulimina affinis. × 50 (after Brady).

BULIMINA ELONGATA d'Orbigny.

Bulimina elongata d'Orbigny, For. Foss. Vienne, 1846, p. 187, pl. 11, figs. 19, 20.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 401, pl 51, figs. 1, and 2?

Description.—Test elongate, subcylindrical, nearly circular in cross section, the chambers numerous, inflated, short, sutures much depressed, apical end rounded, occasionally with minute spines; wall calcareous, smooth; aperture broad and rounded, with a broad plate-like tooth, partially filling the opening; color white.

Length 0.50–1.00 mm.

Distribution.—A few specimens from the western North Pacific seem referable to this species, at least to the form figured by Brady, which is stouter than the type. These were from *Nero* station 1299, in 1,817 fathoms, south of Japan, and *Albatross* station H4891, in 756 fathoms, in Yezo Strait.

The form of the apertural tooth in the specimen figured is a peculiar one. It is broad, but instead of being like the one figured by Brady is slightly bifurcate, with a median ridge from which the two sides gradually slope away, as shown in the figure. This is a rather peculiar type of apertural tooth for this family.

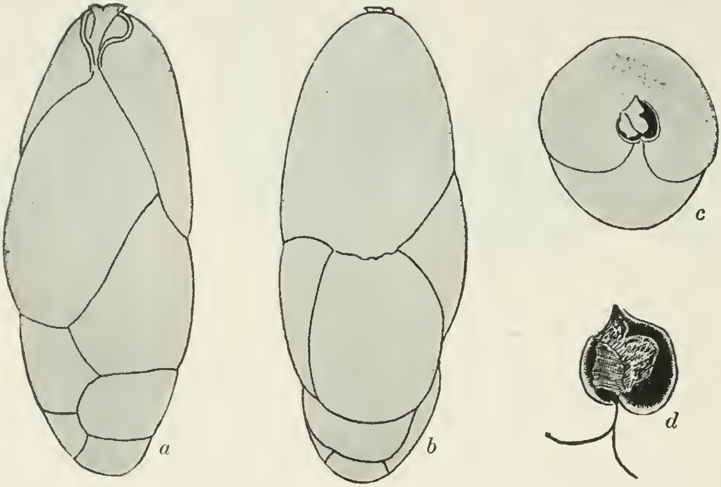


FIG. 131.—BULIMINA ELONGATA. *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, END VIEW. × 60. *d*, VIEW OF APERTURAL REGION. × 120.

BULIMINA PUPOIDES d'Orbigny.

Bulimina pupoides D'ORBIGNY, For. Foss. Vienne, 1846, p. 185, pl. 11, figs. 13, 14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 400, pl. 50, figs. 15*a*, *b*.

Description.—Test ovate, broadest near the apertural end; apical end bluntly pointed, tapering; end view nearly circular; visible chambers numerous, much inflated; sutures rather deeply depressed; wall smooth; aperture long and narrow, with a narrow plate-like tooth; color white.

Length about 1 mm.

Distribution.—Bagg records this species from two *Albatross* stations, D4174 and D4025, in 275–865 fathoms, near the Hawaiian Islands. The only specimens I have seen were from near the Galapagos Islands, in 1,379 fathoms.

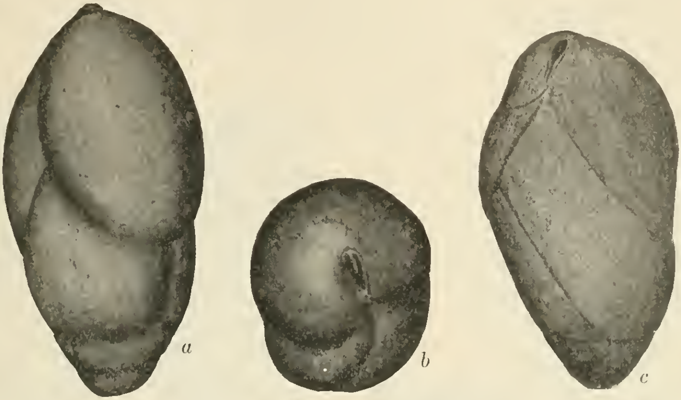


FIG. 132.—BULIMINA PUPOIDES. × 40. *a*, DORSAL VIEW; *b*, END VIEW; *c*, VENTRAL VIEW.

BULIMINA TORTA, new species.

Description.—Test elongate, broadest near the apertural end, tapering to the subacute apical end; apertural end broadly rounded; early portion slightly compressed; later portion circular in cross section; chambers several, somewhat inflated; sutures depressed; wall calcareous, perforate, smooth; aperture very long and narrow, curved, broadest at the upper end; color white.

Length 0.65 mm.

Type-specimen.—Cat. No. 8341, U.S.N.M., from *Albatross* station H2902, in 1,783 fathoms, northeast of the Hawaiian Islands.

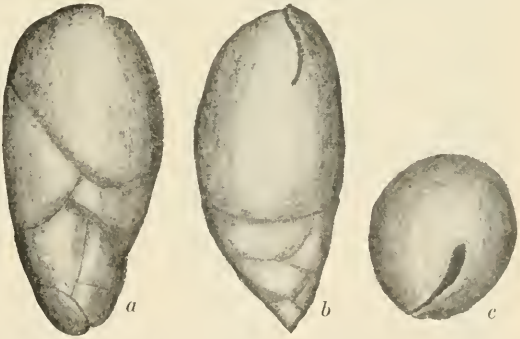


FIG. 133.—BULIMINA TORTA. × 60. *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, END VIEW.

The aperture of this species is very elongate, with no apertural tooth present in this specimen. The chambers in dorsal view have an irregular arrangement, becoming regularly placed in ventral view.

BULIMINA ELEGANS d'Orbigny.

Bulimina elegans d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 270, No. 10; Modèles, 1826, No. 9.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 20, pl. 2, fig. 64.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 398, pl. 50, figs. 1–4.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 284, pl. 8, figs. 66, 67.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 290, pl. 36, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1900, p. 274, pl. 2, fig. 1.

Description.—Test elongate, conical, tapering to the acutely pointed, sometimes mucronate, apical end; chambers numerous, inflated; sutures deeply depressed; wall calcareous, smooth; aperture short, broad, and rounded; color, white.

Length 0.50–0.85 mm.

Distribution.—The species has not previously been recorded from the North Pacific. The specimens I have examined were from various stations off the coast of Japan, in 282–584 fathoms, and from Bering Sea, in 536 fathoms.

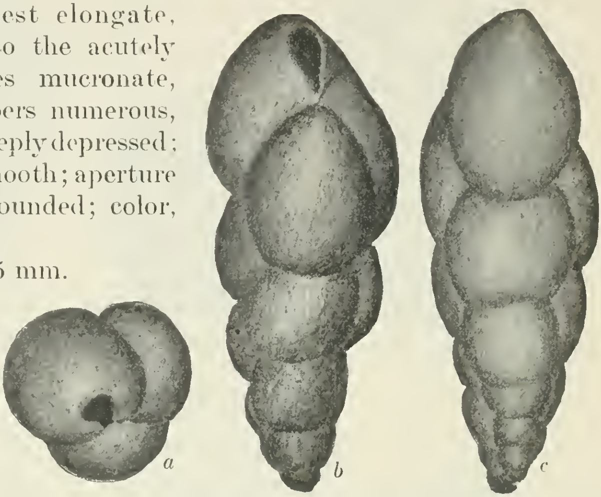


Fig. 134.—Bulimina elegans. × 60. *a*, apertural view; *b*, ventral view; *c*, dorsal view.

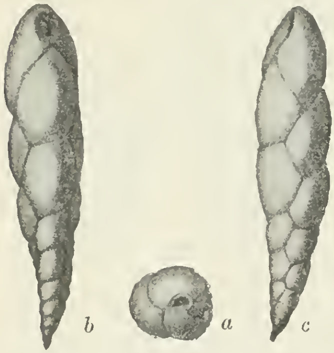


Fig. 135.—Bulimina elegans, var. exilis. × 60. *a*, apertural view; *b*, side view; *c*, front view (after Brady).

BULIMINA ELEGANS d'Orbigny, var. EXILIS H. B. Brady.

Bulimina elegans d'Orbigny, var. *exilis* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 399, pl. 50, figs. 5, 6.—Millett, Journ. Roy. Micr. Soc., 1900, p. 275.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 12, pl. 1, fig. 11.

Description.—"Test much elongated, slender, tapering, more or less compressed on three sides; oral end subacute or rounded, aboral extremity acuminate. Segments numerous, oblique, somewhat inflated, arranged in a regular triserial spire."

Length 0.75 mm.

Distribution.—Brady records this variety from the North Pacific at *Challenger* station 232, in 345 fathoms, on the *Hyalonema*-

ground south of Japan. I have not found any specimen sufficiently elongated to warrant their being placed in this variety. The figure and description are from Brady.

BULIMINA MARGINATA d'Orbigny.

Bulimina marginata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, No. 4, pl. 12, figs. 10–12.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 296, pl. 11, figs. 35–40.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 405, pl. 51, figs. 3–5.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 43, figs. 7, 10.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 474.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 287, pl. 8, figs. 69, 70.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 46, pl. 9, figs. 439–444.—MILLETT, Journ. Roy. Micr. Soc , 1899. p. 277.

Bulimina pupoides, var. *marginata* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 62, pl. 5, figs. 126, 127.

Bulimina presli, var. *marginata* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 372, pl. 15, fig. 10; pl. 17, fig. 70.

Description.—Test ovate or tapering; chambers numerous, inflated, all visible from the exterior; sutures deep; lower margins of the chambers extending back with a free edge which is serrate, or may be only crenulate, or even spinose; remaining portion of chamber smooth and unornamented; wall thin and transparent, or in older specimens thickened, white, and nearly opaque; aperture a comma-shaped slit in a slight depression of the inner face of the chamber, with a slightly raised border.

Length usually under 1 mm., but some specimens slightly larger.

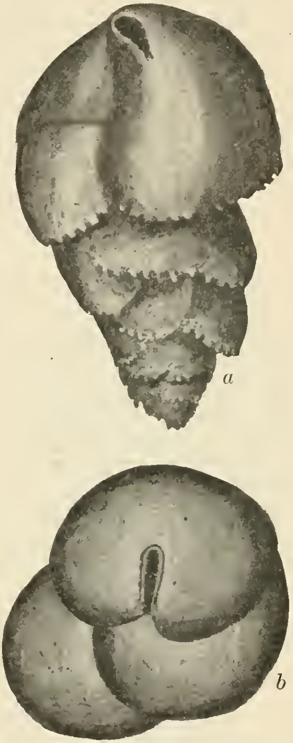


FIG. 136.—BULIMINA MARGINATA. × 150. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

Distribution.—This species has been recorded once from the North Pacific. It occurred at *Challenger* station 232 on the *Hyalonema*-ground south of Japan, in 345 fathoms. In the present collection I have seen specimens from two *Albatross* stations off Japan, D4972, in 440 fathoms, and D5056, in 258 fathoms. Specimens were also found in the *Nero* material from three stations near the Bonin Islands, south from Japan, in 1,208–1,760 fathoms. All the records for this species in the North Pacific are therefore from the faunal region of Japan, and adjacent waters. The recorded distribution of the species elsewhere is very wide, both as to geographical and bathymetrical range.

The species may be confused on one hand with *Bulimina inflata*, which, however, has ribs running up on the face of the chambers, these in *B. marginata* being smooth, and with *B. aculeata* on the other hand, which has long spines over the chamber wall on the early chambers, in adult specimens the last formed chambers being smooth. In *B. marginata* the lower margins of all chambers are serrate with little difference in the earlier and later formed in this respect.

BULIMINA INFLATA Seguenza.

Bulimina inflata SEGUENZA, Atti Accad. Gicenia Sci. Nat., ser. 2, vol. 18, 1862, p. 109, pl. 1, fig. 10.—SCHWAGER, *Novara* Exped. geol. Theil, vol. 2, 1866, p. 246, pl. 7, fig. 91.—H. B. BRADY, Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 406, pl. 51, figs. 10–13.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 43, fig. 9.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 474.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 288, pl. 8, fig 85.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 22.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 46.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 279.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 135.

Description.—Test short, ovate, composed of overlapping chambers, triserial, the sutures deep; edge of chamber extending out into a free winglike expansion with a crenulated border extending outward into short spines, from which raised costæ extend back into the outer surface of the chambers; upper portions of the chambers smooth and unornamented; wall transparent and thin in the young, becoming thickened and white in the adult; aperture an obliquely placed slit, elongated, widest near the upper end, usually with a raised border, and often with a lip extending in on the concave side.

Length, 0.4–1.0 mm.

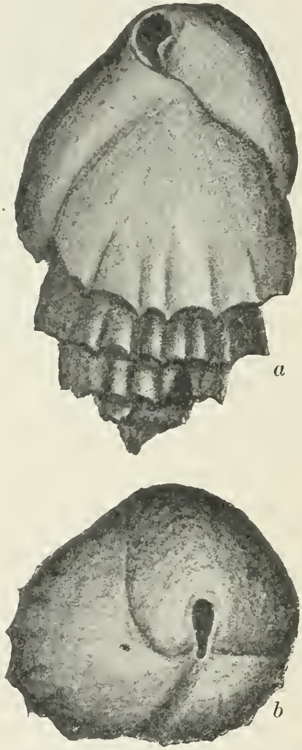


FIG. 137.—BULIMINA INFLATA. × 60. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

Distribution.—This species seems to be widely distributed in the North Pacific. It was recorded by Brady from *Challenger* station 209, in 95 fathoms, near the Philippine Islands. Goës records it from two *Albatross* stations in the eastern part of the tropical Pacific, in 695 and 995 fathoms. Bagg found it in material from four *Albatross* stations near the Hawaiian Islands, in 384–1,307 fathoms. In my own work I have found specimens from a large number of stations, especially in the Western Pacific about Japan, and southward, and also in the deeper water in various places. It has occurred also in material from between Hawaii and the western coast of America. Of these various stations the shallowest at which I have found the species is 181 fathoms, and the deepest 1,417 fathoms.

The species, although widely distributed, has not been met with in any considerable numbers at any one station.

Brady speaks of this species as a transition form connecting *Bulimina aculeata* and *B. buchiana*, but it has always been easily distinguished from either of these two species in the material I have examined. In a large list of stations the two species *B. inflata* and *B. buchiana* occurred at the same station but twice.

As far as the North Pacific is concerned *Bulimina inflata* seems to be the most common species of the genus.

BULIMINA BUCHIANA d'Orbigny.

Bulimina buchiana d'Orbigny, For. Foss. Vienne, 1846, p. 186, pl. 11, figs. 15–18.—Reuss, Sitz. kais. Akad. Wiss. Wien, vol. 55, 1867, p. 95, pl. 4, figs. 10*a*, *b*.—Terrigi, Atti Acc. Pont. Nuovi Lincei, vol. 33, 1880, p. 195, pl. 2, fig. 37.—H. B. Brady, Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 407, pl. 51, figs. 18, 19.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 474.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 286, pl. 8, figs. 68, 77.—Chapman, Proc. Zool. Soc. London, 1895, p. 22.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 135.

Bulimina presli, var. *buchiana* Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 374, pl. 17, fig. 71.

Bolivina karreriana Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138 (not *B. karreriana* H. B. Brady).

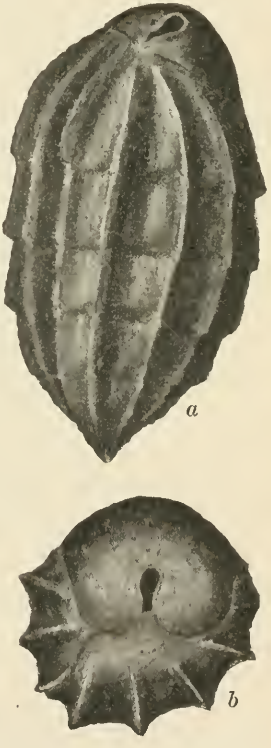


Fig. 138.—Bulimina buchiana. × 150. *a*, front view; *b*, apertural view.

Description.—Test ovate, short, composed of numerous inflated chambers; sutures fairly deep, triserial; chambers visible from base to apex; ornamentation consisting of a series of raised costæ, usually three to five on each chamber, and becoming confluent with those on the chambers directly above and below, so that the test has the appearance of bearing longitudinal costæ from the early chambers to the basal portion of those last formed; wall thin and transparent in young specimens, in adults becoming thickened, white, and opaque, perforate; final series of chambers smooth above; aperture a looplike opening on the inner margin of the chamber.

Length, 0.3–0.8 mm.

Distribution.—The only previous records for this species in the North Pacific are those of Bagg from near the Hawaiian Islands, at *Albatross* stations H4568, in 1,274 fathoms, and H4585, in 689 fathoms. His selected specimens appear to be typical. Brady did not find the species in the *Challenger* material from the North Pacific. In the *Albatross* and *Nero* material that I have examined this species has occurred at numerous stations. These are for the most part in the western portion of the area. As a rule the depths at which this species has been taken correspond well with the observations of Brady on the *Challenger* material. All of our stations come within the range given by Brady. The shallowest occurrence of the species in this material is 440 fathoms and the deepest 2,086 fathoms. The great majority of the stations are in water between 1,000 and 2,000 fathoms in depth.

The figured specimen is not an adult, the costæ on all but the last-formed chamber reaching well up toward the upper end, while in the adult, as a rule, the three chambers last formed are comparatively smooth. The overlapping appearance is seen in profile at the sides.

An examination of Bagg's specimen recorded as *Bolivina karreriana* shows it to be a young specimen of *Bulimina buchiana*.

BULIMINA ACULEATA d'Orbigny.

Polymorpha pineiformis Soldani, Testaceographia, vol. 1, pt. 2, 1791, p. 118, pl. 127, fig. I, pl. 130, fig. VV.

Bulimina aculeata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 269.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 406, pl. 51, figs. 7–9.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 43, fig. 8.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 287, pl. 8, figs. 72, 78.—Chapman, Proc. Zool. Soc., London, 1895, p. 22.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 45.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 4.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 134.

Bulimina pupoides, var. *spinulosa* Williamson, Rec. For. Great Britain, 1858, p. 62, pl. 5, fig. 128.

Bulimina presli, var. *aculeata* Parker and Jones, Intr. Foram., 1862, Appendix, p. 311.

Description.—Test elongate, tapering, triserial, the early chambers with rather stout aculeate spines, in part from the projecting border of the chamber and in part from its outer surface above the projecting portion; later chambers in adult specimens typically smooth and inflated, with depressed sutures; wall calcareous, perforate, in adult specimens white and opaque; aperture a slightly curved looplike opening at the lower inner border of the chamber.

Length, 0.4–0.8 mm.

Distribution.—This species is very widely distributed in the various ocean basins. In the North Pacific it is recorded by Brady from one *Challenger* station, 232, in 345 fathoms, on the *Hyalonema*-ground south of Japan. Bagg records it from a single *Albatross* station, H4567, in 1,307 fathoms, near the Hawaiian Islands. Goës did not note the species in the eastern Pacific material examined by him, and I have failed to find it in material from the same region. Just east of the Hawaiian Islands it has been noted in material from a few stations, in 1,424–2,615 fathoms. I have found it also at one station just off the Hawaiian Islands, in 392 fathoms. It has occurred at a great number of stations in the Western Pacific, about Japan and in the region to the south. The depth of the stations at which it was taken range from 76 to 1,299 fathoms, with the average depth between 500 and 1,000 fathoms.

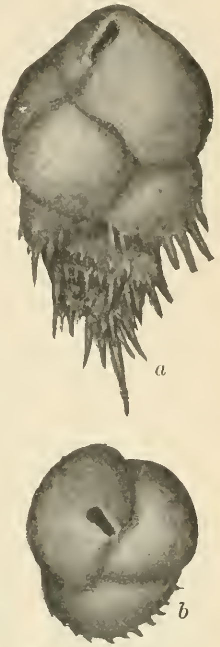


FIG. 139.—BULIMINA ACULEATA. × 75. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

From a study of the various figures of specimens assigned to this species it would seem as though there were two or more distinct forms confused under this name. The most common and typical form seems to be that figured here and in the *Challenger* report on plate 51, fig. 8. In the North Pacific this is the common form.

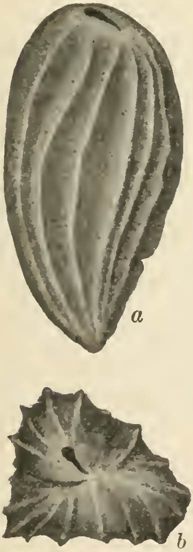


FIG. 140.—BULIMINA ROSTRATA. × 150. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

BULIMINA ROSTRATA H. B. Brady.

Bulimina rostrata H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 408, pl. 51, figs. 14, 15.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 287, pl. 8, figs. 96, 97.

Description.—Test ovoid, tapering to an acute point, sometimes with a distinct apical spine; chambers arranged triserially, but indistinct in front view; surface with a series of raised costæ running from the apical end to the last-formed whorl, concealing the sutures; end view showing the sutures; wall punctate, opaque, white; aperture elongate, comma-shaped.

Length 0.3–0.5 mm.

Distribution.—Brady found this species in material from four *Challenger* stations in rather deep water in the South Atlantic and

Southern Ocean, between the Cape of Good Hope and Kerguelen Island, and off the Ki Islands. Egger in the *Gazelle* report records it once from West Australia; but his figures do not indicate typical specimens. It has not previously been recorded from the North Pacific. I have specimens of this species from six stations widely scattered in this area, as follows: *Albatross* station H2899, in 1,531 fathoms, near the Hawaiian Islands; *Nero* stations 170, east of Midway Island, in 1,990 fathoms; 1123, 1185, and 1208, near the Bonin Islands, in the Western Pacific in 1,877, 1,491, and 665 fathoms, respectively; and *Albatross* station D4957, in 437 fathoms, off Japan.

This seems to be a small species, distinct from *Bulimina buchiana*, with continuous costæ of sufficient strength to obscure the sutures of the test.

BULIMINA SUBORNATA H. B. Brady.

Bulimina subornata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 402, pl. 51, figs. 6*a*, *b*.

Description.—"Test oblong-ovate; resembling that of *Bulimina pupoides* in general form and segmentation; the earlier chambers ornamented externally with raised longitudinal costæ; the aboral extremity generally armed with a stout spine. Shell-wall conspicuously ornamented."

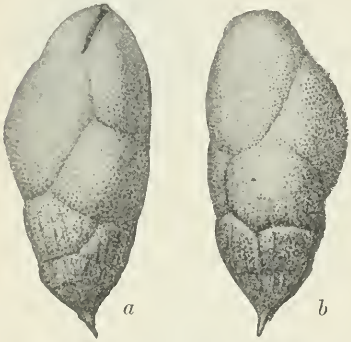


Fig. 141.—Bulimina subornata. × 80. *a* front view; *b*, side view. (After Brady).

Length 0.5 mm.

Distribution.—This species was described by Brady from material dredged by the *Challenger* on the *Hyalonema*-ground, south of Japan, in 345 fathoms. It is very interesting to note that the only specimen of this species obtained from the North Pacific material examined was from *Albatross* station D5090, in 200 fathoms, but a few miles from the spot where this species was obtained by the *Challenger*. This specimen might have been used for Brady's figure, so exactly is it like the figure in the *Challenger* report in its details. The description and figure are from Brady.

BULIMINELLA, new genus.

Bulimina (part) d'Orbigny, Foram. Amér. Mérid., 1839, p. 51.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 397.

Description.—Test composed of chambers triserially arranged, but in later development becoming involute and spirally coiled, the aperture being in the umbilicus thus formed; wall calcareous, perforate; aperture in the species but little twisted spirally, long and narrow, nearly vertical, in the closely spiral species becoming rounded in the middle of the concave umbilical area.

This genus contains species such as *Buliminella elegantissima* (d'Orbigny), where the spiral form of the test is very marked, and others which show a lesser tendency toward the spire, such as *Buliminella subteres* (H. B. Brady), *B. declivis* (Reuss) and *B. contraria* (Reuss). It is very different from typical *Bulimina*, with its simple triserial arrangement of the chambers.

Type-species.—Buliminella elegantissima (d'Orbigny).

BULIMINELLA SUBTERES (H. B. Brady).

Bulimina presli, var. *elegantissima* Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 374, pl. 15, figs. 12–17.

Bulimina elegantissima (var.) H. B. Brady, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 436, pl. 21, fig. 12.

Bulimina subteres H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 55.—Wright, Proc. Belfast Nat. Field Club, 1880–81, App. p. 180, pl. 8, figs 2, 2*a*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 403, pl. 50, figs. 17, 18.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 289, pl. 8, figs. 73, 74.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 46, pl. 9, figs. 445–453.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 10.

Description.—"Test elongate-ovate, tapering to a blunt point at the initial extremity, rounded at the distal end; consisting of from two to three more or less regular, oblique convolutions. Chambers relatively large and only slightly ventricose externally; sutural lines very distinct. Aperture a curved slit near the inferior umbilical margin of the terminal chamber, considerably removed from the distal end of the test."

Length 0.4–0.6 mm.

Distribution.—A single specimen of this species was found in material from *Nero* station 1254, in 264 fathoms, south of Japan. It appears to be the only record for this region, although Brady records it from eight stations in the South Pacific.

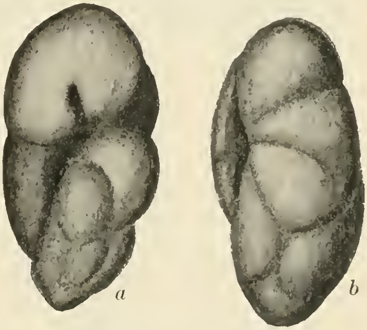


Fig. 142. Buliminella subteres. × 80. *a*, apertural view; *b*, side view.

The *Nero* specimen matched exactly the figure given by Brady and reproduced here. The description is from Brady.

BULIMINELLA CONTRARIA (Reuss).

Rotalina contraria Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 76, pl. 5, fig. 37.

Bulimina contraria H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 409, pl. 54, fig. 18*a*, *b*, *c*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 288, pl. 8, figs. 81, 82.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 135.

Cassidulina jonesiana H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59.

Description.—Test coiled in a depressed spire, umbilicate, the chambers numerous, slightly inflated; sutures distinct, slightly depressed;

wall smooth, calcareous; aperture distinctly bulimine, loop-like, rather long and narrow, extending to the umbilicus; color white.

Diameter about 0.75 mm.

Distribution.—Recorded by Brady from the *Hyalonema*-ground, south of Japan, in 345 fathoms, and by Bagg from three *Albatross* stations near the Hawaiian Islands, D4000, H4430, and H4555, in 104–1,544 fathoms.

This is a rather anomalous species, but seems to be related to the other species of the *Bulimina* group by its aperture, and to *Buliminella* by its spirally coiled form.

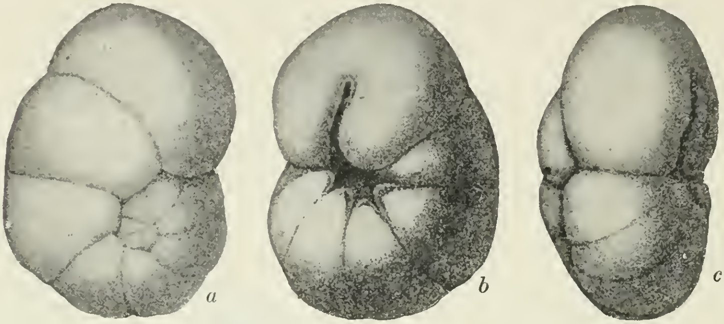


Fig. 143.—Buliminella contraria. × 60. *a*, dorsal view; *b*, ventral view; *c*, peripheral view (after Brady).

BULIMINOIDES, new genus.

Description.—Test triserial, spiral, elongate, subcylindrical; wall calcareous, perforate; aperture nearly circular, terminal, in a depression of the truncated apertural end.

This genus differs from true *Bulimina* in its spiral cylindrical form and its central, circular, terminal aperture. It contains but one species, *B. williamsoniana* (H. B. Brady).

Type-species.—*Buliminoides williamsoniana* (H. B. Brady).

BULIMINOIDES WILLIAMSONIANA (H. B. Brady).

Bulimina williamsoniana H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 56; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 408, pl. 51, figs. 16, 17.—Millett, Journ. Roy. Micr. Soc., 1900, p. 279, pl. 2, fig. 8.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 136.

Description.—Test subcylindrical, elongate, spirally twisted, triserial, slightly tapering, the apical end broadly rounded, the apertural end obliquely truncated, depressed; chambers numerous, long and narrow, obliquely placed; sutures not clearly marked, being hidden by the surface ornamentation; wall calcareous, perforate, ornamented with a series of longitudinal costæ, somewhat twisted, following over the apertural end and continuing to the edge of the aperture, occasionally bifurcating; aperture terminal, central, circular, situated in the center of the depression at the apertural end; color, white.

Length 0.50–0.80 mm.

Distribution.—The only North Pacific record for this species is given by Bagg, *Albatross* station H4694, in 865 fathoms, off the Hawaiian Islands. I have had material from *Albatross* station H2922 in 268 fathoms, also off the Hawaiian Islands.

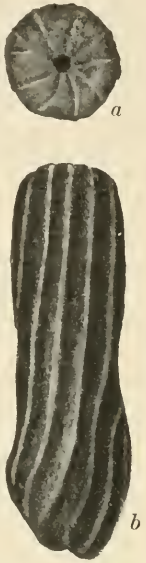


FIG. 144.—BULIMINOIDES WILLIAMSONIANA. × 60. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

The species seems to be a tropical or subtropical one, being found in the area from northern Australia through the South Pacific and Malay Islands, a not uncommon distribution for other species found in the Hawaiian waters.

Genus VIRGULINA d'Orbigny, 1826.

Virgulina d'Orbigny (type, *V. squamosa* d'Orbigny). Ann. Sci. Nat., vol. 7, 1826, p. 267.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 413.

Bulimina (part) Bailey, Smiths. Contr. Knowledge, vol. 2, 1851, p. 12.—Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 296; Philos. Trans. Roy Soc., vol. 155, 1865, p. 375.—Williamson, Rec. Foram. Great Britain, 1858, p. 63.

Description.—Test elongate, made up of chambers from one side biserial, from the other more or less spiral or irregular; wall calcareous, perforate; aperture large, comma-shaped, on the inner portion of the chamber; color, white.

This genus, including but a few species, has a wide distribution in the present seas and is found fossil especially in the later tertiary. On the one hand it is related to *Bulimina*, and on the other hand many of its characters are not unlike *Bolivina*, especially the aperture.

VIRGULINA SQUAMOSA d'Orbigny.

Virgulina squamosa d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 267; Modèles, No. 64.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 66; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 415.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 291, pl. 8, figs. 98, 104.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, pt. 9, 1894, p. 47, pl. 9, figs. 454, 456, 460; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 46.—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 13, pl. 3, fig. 5.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 136.

Description.—Test elongate, tapering, the chambers oblique, longer than wide; test becoming much wider toward the apertural end, thin;

walls calcareous, smooth, and polished; sutures clearly marked, but not deep; aperture elongate, narrow, comma-shaped; color, white.

Length about 0.50 mm..

Distribution.—This species is well distributed over the North Pacific in water of medium depths, few stations being less than a thousand fathoms.

There is some confusion as to the application of d'Orbigny's name, but it is here applied to the rather thin, broad, tapering form with oblique chambers, such as is shown by d'Orbigny's model. With such an application it may be rather easily distinguished from the more rotund, less tapering *V. subsquamosa* Egger.

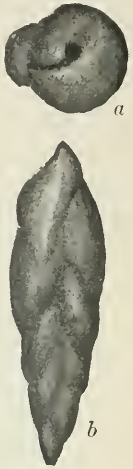


Fig. 145.—Virgulina squamosa, modified from the original. *a*, apertural view; *b*, front view.

VIRGULINA SUBSQUAMOSA Egger.

Virgulina subsquamosa Egger, Neues Jahrb., 1857, p. 295, pl. 12, figs. 19-21.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 415, pl. 52, figs. 9-11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 291, pl. 8, figs. 89, 90, 109.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, pt. 9, 1894, p. 49, pl. 9, figs. 473-474; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 46.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 7.—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 13.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 136.

Description.—Test elongate, tapering, the chambers somewhat oblique, with slightly depressed sutures, slightly inflated in the narrower forms; test in side view somewhat curved; walls calcareous, smooth and polished; aperture elongate, fairly broad, comma-shaped; color, white.

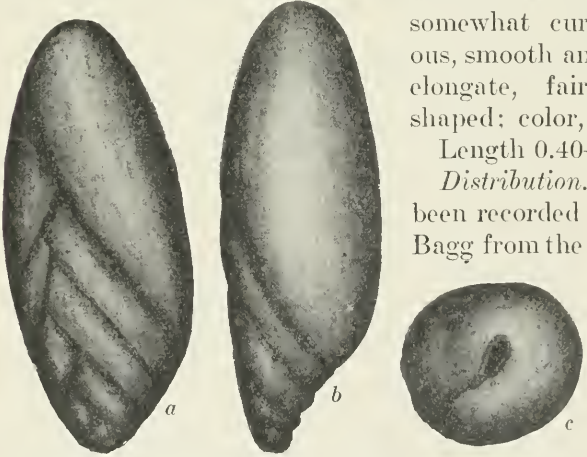


Fig. 146.—Virgulina subsquamosa. × 120. *a*, front view: *b*, side view; *c*, apertural view.

Length 0.40-0.65 mm.

Distribution.—This species has been recorded by Brady, Goës, and Bagg from the North Pacific; from the *Hyalonema*-ground, 345 fathoms, off Japan by Brady; from the eastern Pacific in 1,132 fathoms by Goës; and from about the Hawaiian Islands by Bagg, in 275-1,544 fathoms. I have found specimens referable to this species from many stations well scattered over the North Pacific.

That there is a decided confusion in regard to this and the foregoing species is evident from a study of the original descriptions and figures and a comparison with later figures. The originals are much closer than later authors have made their diagnoses of the two, and it is now difficult, without a large series of specimens, to determine clearly the limits of the species as they exist at present. Unfortunately, although the material studied from the North Pacific is from many stations, the number of specimens from any one station is too small to admit of a comparative study of variation. A large series would probably show that there are definite species with more or less clearly defined distribution, as has been elsewhere found to be the case when conditions were favorable for such a study.

VIRGULINA SUBSQUAMOSA Egger, var. STRIATA Bagg.

Virgulina squamosa striata BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 137, pl. 5, fig. 7.

Description.—Test elongate, slightly tapering, bluntly rounded at the apical end, obliquely truncate at the apertural end; the chambers about as broad as high, somewhat rotund; the sutures distinct; wall calcareous, polished, ornamented with longitudinal costæ; color, white.

Length about 0.50 mm.

Distribution.—Described from *Albatross* station D4025, in 275–368 fathoms, near the Hawaiian Islands.

A study of the type specimen seems to place the species rather as related to *V. subsquamosa* Egger rather than to *V. squamosa* d'Orbigny as here considered. It may be a good species, but further material is desirable for study before this can be determined.

VIRGULINA SUBDEPRESSA H. B. Brady.

Virgulina subdepressa H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 416, pl. 52, figs. 14–17.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 291, pl. 8, fig. 103.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 47.

Description.—Test elongate, subcylindrical, slightly compressed; the chambers fully as high as broad, inflated, the sutures deep; outline distinctly crenulate; apical end of test broadly rounded; wall calcareous, smooth and polished; aperture fairly broad, comma-shaped; color, white.

Length about 1 mm.

Distribution.—Goës records this species from a single station off the western coast of America, in 730 fathoms. I have seen material from four stations, *Albatross* station

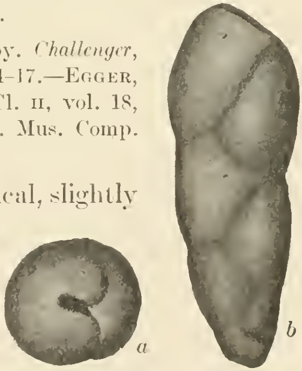


FIG. 147.—VIRGULINA SUBDEPRESSA. × 50. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

H4856, 898 fathoms, Bering Sea, *Nero* station 170 in 1,990 fathoms near Midway Island, and *Nero* stations 1128 and 1123 in 1,418 and 2,049 fathoms in the Western Pacific.

From the material examined the characters of this species seem to be well defined. It is more cylindrical in form than any of the other recent species, and its shape, with the triangular outline of the inflated chambers, distinguishes it from the other species.

The original stations given by Brady are all in deep water, as are also the *Gazelle* stations, from which the species is recorded by Egger.

VIRGULINA SCHREIBERSIANA Czjzek.

Virgulina schreibersiana Czjzek, Haidinger's Nat. Abhandl., vol. 2, 1848, p. 147, pl. 13, figs. 18–21.—Egger, Neues Jahrb., 1857, p. 295, pl. 12, figs. 12–14.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 414, pl. 52, figs. 1–3.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 290, pl. 8, figs. 93, 95.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 48, pl. 9, figs. 459, 461–472.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 6.—Fornasini, Mem. Accad. Sci. Instit. Bologna, ser. 5, vol. 7, 1898, p. 206, pl., fig. 6.—Millett, Journ. Roy. Micr. Soc., 1900, p. 280, pl. 2, fig. 13.—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5. 1905, p. 13, pl. 3, fig. 4.

Bulimina presli, var. (*Virgulina*) *schreibersii* Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 375, pl. 15, fig. 18; pl. 17, figs. 72, 73.

Description.—Test much elongated, narrow, tapering, compressed, slightly curved in side view, the apical end tapering to a blunt point; the chambers much longer than wide, oblique; the sutures distinct, slightly compressed; wall calcareous, smooth and polished; aperture rather broad and widely open, loop-shaped; color white.

Length 0.30–0.50 mm.

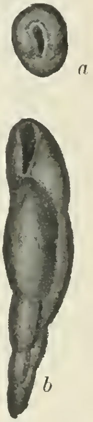


Fig. 148.—Virgulina schreibersiana. × 60. *a*, apertural view; *b*, front view.

Distribution.—Recorded by Brady from two *Challenger* stations in the North Pacific in deep water, in 2,425 and 3,125 fathoms. I have had material from a number of stations, all in the western Pacific, two stations, in 891 fathoms and 1,331 fathoms, being the only two in less than 1,500 fathoms, more than half the stations being in water more than 2,000 fathoms in depth.

This is another of the species in which there is great confusion, as a study of published figures will show. From the material at hand there seem to be rather definite groupings into two or more distinct forms, but more of a series is necessary to define these with certainty.

VIRGULINA TEXTURATA H. B. Brady.

Virgulina texturata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 415, pl. 52, figs. 6, *a*, *b*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 292, pl. 8, fig. 99.

Description.—Test elongate, subcylindrical, gradually tapering to the subacute apical end, somewhat compressed; chambers numerous, inflated, about as broad as high, the sutures distinctly depressed; wall calcareous, smooth and polished; aperture elongate, loop-shaped; color white.

Length 1.0–1.3 mm.

Distribution.—Although not previously recorded from the North Pacific, this species has occurred at three stations, *Albatross* station H2902, in 1,783 fathoms, and *Nero* stations 166 and 170, in 1,850 and 1,990 fathoms.

The specimens from *Nero* station 166 were very smooth and somewhat different from the typical ones found at the other stations.

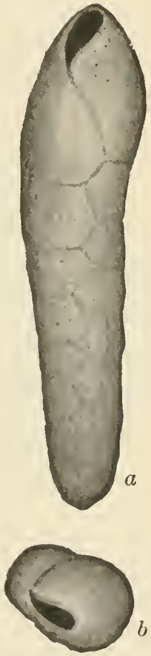


Fig. 149.—Virgulina texturata. × 35. *a*, front view; *b*, apertural view.

Subfamily 4. CASSIDULININÆ.

This subfamily includes forms which are peculiarly constructed in that there is a combination of two distinct modes of growth. One of these, so usual in this family, is the biserial, which is here combined with a spiral or volute method. The combination of the two makes a complex test.

Two genera are common in the North Pacific, *Cassidulina* and *Ehrenbergina*, both of which are represented by more than one species.

Genus CASSIDULINA, d'Orbigny, 1826.

Cassidulina d'Orbigny (type, *C. lævigata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 282.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 427.

Description.—Test coiled, at least the earlier portion, and the chambers biserially arranged on the sides of the axis of coiling; wall calcareous, perforate, usually smooth; the chambers numerous, with distinct sutures; aperture loop-like, variously modified in the different species.

The most lucid description of the arrangement of the chambers in this genus is that given by Brady, as follows: "The arrangement of the test in *Cassidulina* is in some respects more complex than that of any other type of Foraminifera, inasmuch as it combines two distinct modes of growth, the biserial and the convoluted. This may be best understood by its analogy, in the typical condition, to a broad Textularian or Bolivine shell, doubled or folded longitudinally on the median line, and then rolled in the crease so formed from the narrow to the broad end. The flaps of each convolution extend nearly or quite to the umbilicus, and completely enclose the previous whorls."

In some species there is the tendency to uncoil as in so many other genera which are close coiled. The various species appear to be widely distributed.

CASSIDULINA LÆVIGATA d'Orbigny.

Cassidulina lævigata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 282, pl. 15, figs. 4, 5; Modèles, 1826, No. 41.—WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 68, pl. 6, figs. 141, 142.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 377, pl. 15, figs. 1–4; pl. 17, fig. 64, *a*, *b*, *c*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 428, pl. 54, figs. 1–3.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 221, pl. 43, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 302, pl. 7, figs. 47, 48, 54–56.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 43, pl. 8, figs. 418–320.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 12, 1896, p. 103, pl. 2, fig. 10.—MILLETT, Journ. Roy. Micr. Soc., 1901, p. 1.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 16.—RHUMBLER, Zool. Jahrb., Abth. Syst., vol 24, 1906, p. 62.

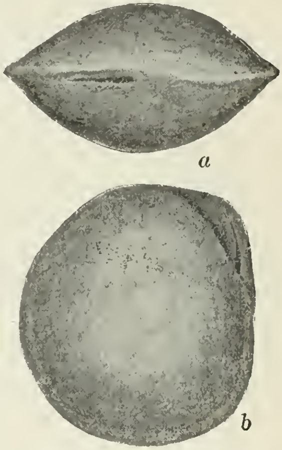


FIG. 150.—CASSIDULINA LÆVIGATA. × 30. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

Description.—Nearly circular in outline, lenticular or biconvex with a thin, carinate, peripheral border; chambers numerous, long and narrow, curved, the surface nearly smooth; sutures distinct but hardly depressed; wall calcareous, perforate, smooth; aperture a long narrow slit just below and nearly parallel to the periphery of the test; color white.

Diameter 0.50–0.90 mm.

Distribution.—Brady records this species as occurring at three stations in the North Pacific. I have material of this keeled form from but one station, *Albatross* station D4822, in 130 fathoms, off Japan. The other species are all more common in the material from this region, but from the colder waters of Bering Sea as well as on the northern coast of western America this species is common. Rhumbler records a very small specimen measuring 0.234 mm. from Chatham Island.

CASSIDULINA CRASSA d'Orbigny.

Cassidulina crassa d'Orbigny, Foram. Amér. Mérid., 1839, p. 56, pl. 7, figs. 18–20; For. Foss. Vienne, 1846, p. 213, pl. 21, figs. 42, 43.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 303, pl. 7, figs. 35, 36.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 43, pl. 8, figs. 421, 422.—Egger, Nat. Ver. Passau, Jahr. 16, 1895, p. 19, pl. 9, fig. 19.—Silvestri, Mem. Pont. Accad. Nuovi Lincei, vol. 12, 1896, p. 104, pl. 2, figs. 11, 12.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 38, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1901, p. 2.—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 17.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 139.

Cassidulina lævigata, var. *crassa* Parker and Jones, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 377, pl. 15, figs. 5–7; pl. 17, fig. 64*d*.

Cassidulina obtusa Williamson, Rec. Foram. Great Britain, 1858, p. 69, pl. 6, figs. 143, 144.

Description.—Outline subcircular or oval, biconvex, with a broadly rounded peripheral border; chambers rather few, short, and inflated, the surface depressed at the sutures; wall calcareous, perforate, smooth; aperture a long narrow slit just below and nearly parallel to the periphery of the test, with a long tooth partially filling the aperture; color, white.

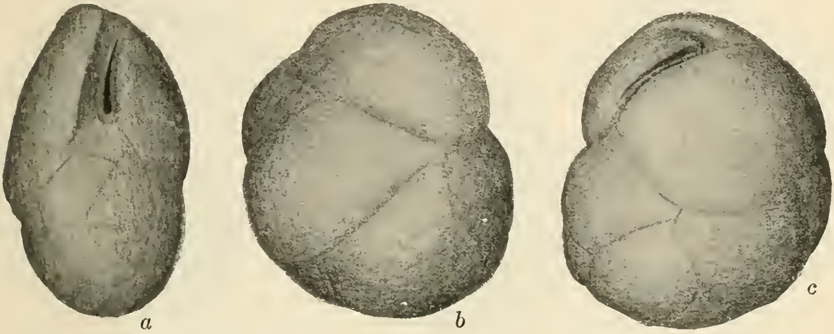


Fig. 151.—Cassidulina crassa. × 30. *a*, apertural view; *b*, dorsal view; *c*, ventral view.

Diameter, 0.60–1.00 mm.

Distribution.—Brady records this species from five stations in the North Pacific at depths varying from 40 to 2,475 fathoms. Bagg records it from *Albatross* stations H4440 and H4694, in 1,259 and 865 fathoms, respectively, off the Hawaiian Islands. I have had material from three stations off Japan, in 120–142 fathoms, from the Okhotsk Sea in 100 fathoms, from the vicinity of the Aleutian Islands, in 500 fathoms, and from off California, in 65 fathoms. This gives a rather general distribution for the area, and specimens are usually in considerable numbers when found. The broadly rounded periphery will distinguish this species from *C. lævigata*, and its more narrow and elongate aperture and more numerous chambers from *C. subglobosa*. When the aperture is viewed from above there is visible a broad tooth-like plate partially filling the aperture except at the upper end. This gives the aperture a very narrow appearance in some views.

In this region at least *C. crassa* seems to be much more common and more widely distributed than *C. lævigata.*

CASSIDULINA SUBGLOBOSA H. B. Brady.

Cassidulina subglobosa H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 60; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 430, pl. 54, figs. 17, *a–c.*—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., London, vol. 12, 1888, p. 221, pl. 43, figs. 12–14.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 304, pl. 7, figs. 41, 42, 52, 53.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 49.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 293, pl. 38, figs. 4.—Chapman, Journ. Linn. Soc., vol. 30, 1907, p. 33, pl. 4, fig. 84.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 140.

Description.—Test with an oval outline, subglobular, inequilateral, somewhat compressed on the two faces, the peripheral border broadly rounded; chambers few, somewhat inflated; sutures slightly depressed, wall calcareous, perforate, smooth; aperture fairly broad and short, looplike or oval; color, white.

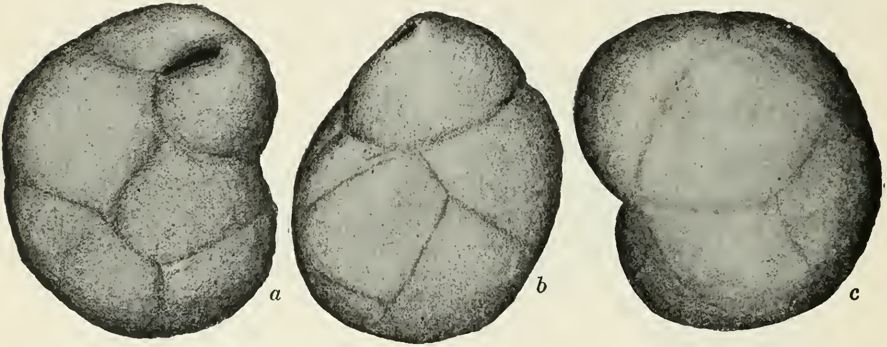


Fig. 152.—Cassidulina subglobosa. × 30. *a*, ventral view; *b*, side view; *c*, dorsal view.

Diameter, 0.50 –1.00 mm.

Distribution.—The two stations in the Northwest Pacific from which Brady records this species are in 2,300 and 2,950 fathoms. Goës records the species from the southeastern part of the area in 770–1,201 fathoms, and Bagg found it in material from three *Albatross* stations near the Hawaiian Islands, H4430, H4571, and H4585, in 384–1,259 fathoms. In the *Nero* material this species was very common in the area between Guam and Japan at an average depth of about 1,500 fathoms. Specimens from the *Albatross* material from off the coast of Japan were dredged in 130 and 200 fathoms. In the *Tuscarora* material this species occurred at several stations: station 2, in 1,468 fathoms, near the Hawaiian Islands; station 13, in 190 fathoms, off the coast of California; station 23, in

1,964 fathoms, in the middle of the Pacific, south of Midway Island; station 41, in 530 fathoms, off California; and station 83, in 282 fathoms, off the western Aleutian Islands. Taken with the other records these give a rather broad distribution, including most parts of the North Pacific, as well as rather wide ranges in depth.

The species is very distinct from the others of the genus, the subglobose form, and the short oval or loop-like aperture serving to distinguish it at once.

CASSIDULINA ELEGANS Sidebottom.

Cassidulina elegans SIDEBOTTOM, Journ. Queckett Micr. Club, ser. 2, vol. 11, 1910, p. 106, pl. 4, figs. 1, *b*, *c*.

Description.—Test somewhat globular, somewhat compressed laterally; chambers numerous, distinct; sutures fairly deep; wall of the distal border of the chambers often raised into a well-marked keel; surface somewhat roughened; aperture a curved loop-like slit, oblique, with a raised border.

Diameter, 0.40–0.60 mm.

Distribution.—This species, recently described by Sidebottom from the Southwest Pacific, occurred at four *Nero* stations between Guam and Japan as follows, 1301, in 1,088 fathoms, 1308, in 1,040 fathoms, 1309, 891 fathoms, and 1464, in 891 fathoms.

This species is ornate with raised ridges and is at once distinguished from all other species of the genus.

CASSIDULINA BRADYI Norman.

Cassidulina bradyi (Norman, MS.) WRIGHT, Proc. Belfast Nat. Field Club, App., 1880, p. 152.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 431, pl. 54, figs. 6–10.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 304, pl. 7, figs. 38–40.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 44, pl. 8, figs. 423–426; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 49.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 17, pl. 3, fig. 10.

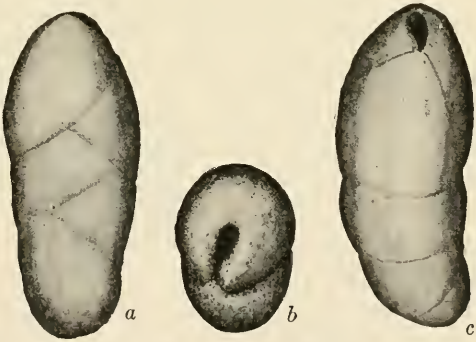


FIG. 153.—CASSIDULINA BRADYI. × 60. *a*, VIEW FROM DORSAL SIDE; *b*, APERTURAL VIEW; *c*, SIDE VIEW.

Description.—Test elongate, compressed, the early portion spirally coiled, the later chambers forming an uncoiled biserial series; lateral faces convex; peripheral border thin, either acute or (usually) somewhat rounded; chambers fairly long, very slightly inflated; suture very slightly depressed; wall calcareous, smooth; aperture broad and short, looplike or oval on the inner face of the chamber; color, white.

Length, 0.40–0.80 mm.

Distribution.—Brady records this species from two North Pacific stations, in 95 fathoms, off the Philippines and, in 345 fathoms, on the *Hyalonema*-ground south of Japan. I have had specimens from *Nero* station 1464, in 891 fathoms, near Guam; station 170, in 1,990 fathoms, off Midway Island, and station 2049, in 2,226 fathoms, near the Hawaiian Islands. There is a single specimen of this species from *Tuscarora* station 47, in 1,499 fathoms, in the Western Pacific. This species is interesting in showing the development of an uncoiled form, a process which is carried still farther by the following.

CASSIDULINA PARKERIANA H. B. Brady.

Cassidulina parkeriana H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 432, pl. 54, figs. 11–16.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 304, pl. 7, fig. 37.

Description.—Test elongate, cylindrical, the very early portion spirally coiled, the later chambers forming an uncoiled biserial series, making up the larger part of the test, circular in cross section; chambers broad and high, considerably inflated; sutures much depressed; wall calcareous, smooth; aperture very broad and short, occasionally subcircular, often with a broad tooth-like plate nearly filling the opening; color, white.

Length, 0.50–0.65 mm.

Distribution.—This species has not been previously recorded from the North Pacific. Brady's specimens were dredged by the *Challenger* among the islands on the west coast of Patagonia, and our specimens are from the same coast of the Pacific. Single specimens were obtained at *Albatross* stations D2806, in 1,379 fathoms, near the Galapagos, and D3608, in 276 fathoms, in the Bering Sea.

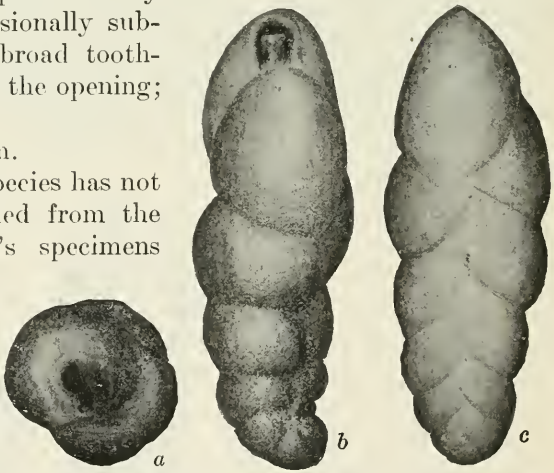


Fig. 154.—Cassidulina parkeriana. × 50. *a*, apertural view; *b*, ventral view; *c*, dorsal view.

The species carries the uncoiling to an extreme and develops a cylindrical test with the aperture nearly terminal and rounded, but keeps to the biserial condition, although in some specimens the chambers nearly separate those adjacent.

Genus EHRENBERGINA Reuss, 1850.

Ehrenbergina REUSS (type, *E. serrata* Reuss), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 377.—H. B. BRADY, Rep Voy *Challenger*, Zoology, vol. 9, 1884, p. 433.

Cassidulina (part) D'ORBIGNY, Foram. Amér. Mérid., 1839, p. 57.

Description.—Test free, composed of numerous chambers arranged biserially about an elongate axis, evenly united on the dorsal border but forming a deep groove on the ventral border, generally triangular in cross section; wall calcareous; aperture elongate, nearly at right angles to the edge of the chamber, smooth or ornamented with spines or ridges.

Brady, in the *Challenger* Report, speaks of this genus as almost confined to the southern hemisphere. This has been largely due to lack of material, in the Pacific at least, for in the present work it has been found at a great many stations and often in very considerable numbers.

EHRENBERGINA SERRATA Reuss.

Ehrenbergina serrata REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 377, pl. 48, fig. 7.—BRONN, Leth. Geog., ed. 3, vol. 3, 1853–6, p. 231, pl. 35, figs. 25 *a–c*.—SCHWAGER, Boll. Roy. Com. Geol. Ital., vol. 8, 1877, p. 26, pl. 68.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 434, pl. 55, figs. 2–7.—EGGER, Ahh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, pl. 7, figs. 30–32.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 44, pl. 8, figs. 428–430.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 26.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 140.

Ehrenbergina serrata, var. *trigona* GOËS, Bull. Mus Comp. Zoöl., vol. 29, 1896, p. 49.

Textularia triquetra MÜNSTER, var., GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 83, pl. 6, figs. 181, 182.

Description.—Test longer than wide, of several chambers, arranged biserially about a central axis, on the dorsal side meeting evenly to form a smooth surface, on the ventral often leaving a deep groove between the two adjacent series of chambers, or smooth; test triangular, ovoid, or biconvex in transverse section; angles of the test carinate, often produced into short spines; wall calcareous, finely perforate; aperture an elongate, somewhat curved slit; color white.

Length about 0.5 mm.

Distribution.—There are a number of records published for this species in the North Pacific. Brady, in the *Challenger* Report, records it from but one station, in 2,340 fathoms. Goës found it in material from two stations, off the west coast of America, *Albatross* stations 3375 and 3400, in 1,201 and 1,322 fathoms; Bagg records it from five *Albatross* stations in the vicinity of the Hawaiian Islands, varying in depth from 367–1,544 fathoms. I have had material from thirty or more stations in the North Pacific. It was found in material from *Albatross* station D2806 in 1,379 fathoms near the Galapagos Islands; it occurred several times in the line of soundings from San Francisco to the Hawaiian Islands, in 392–2,615 fathoms, and in the *Nero* material from about the Hawaiian Islands and Guam, and is common between Guam and Japan at many stations. Among variously scattered *Tuscarora* stations it occurs in 500 fathoms just south of the Aleutian Islands. It is a fairly common constituent of globigerina-ooze and volcanic muds in a number of areas of the North Pacific, according to the data available.

There seems to be some variation in the shape and the amount of spinosity developed. In general the more triangular forms are most spinose and the biconvex forms often almost smooth and frequently with the long axis of the test considerably curved.

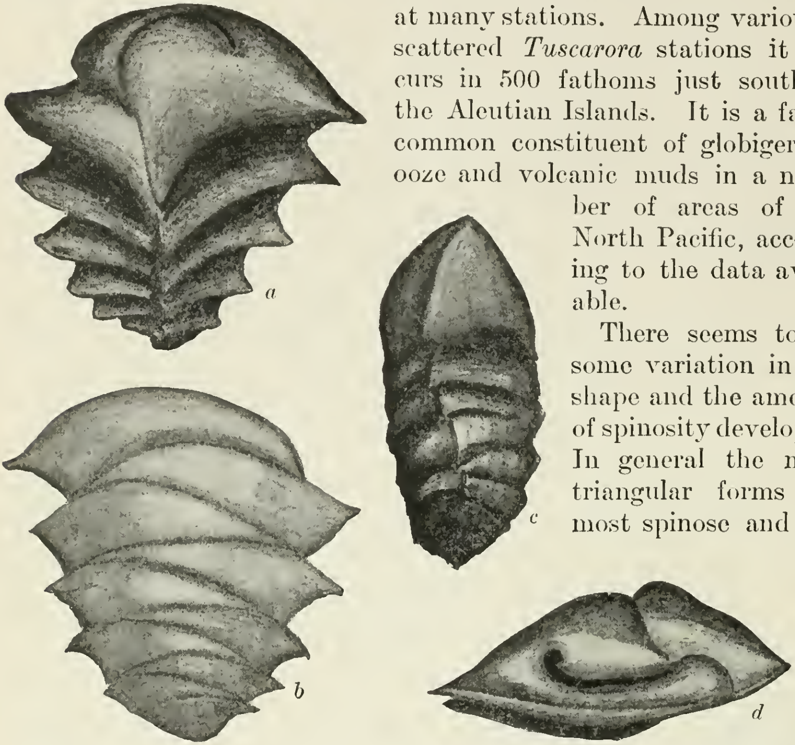


FIG. 155.—EHRENBERGINA SERRATA. × 75. *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW; *d*, APERTURAL VIEW.

EHRENBERGINA HYSTRIX H. B. Brady.

Ehrenbergina hystrix H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 60; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 434, pl. 55, figs. 8–11.—FLINT, Bull. 55, U. S. Nat. Mus., 1905, pp. 16, 19.

Description.—Test free, biserial, nearly as broad as long, stout; dorsal border with spines often coalescing laterally to make a fringe-like projection, later chambers smooth dorsally, the lateral margins and ventral portion with large stout spines, the last developed chamber often smooth and somewhat inflated, marked with fine raised lines running radially outward from the aperture; wall fairly thick, calcareous; aperture elongate, rounded at the inner end; color white.

Length up to 1 mm.

Distribution.—The only published records for the North Pacific are those of Flint, who found it in the *Nero* material from three stations. I have found it in material from two of these same stations and from a number of others, most of them northwest of the Hawaiian Islands. It occurred also near the Bonin Islands and at one *Albatross* station, H2902, east of the Hawaiian Islands. All of these records are from rather deep water, ranging from 1,321–2,203 fathoms, mostly from globigerina ooze.

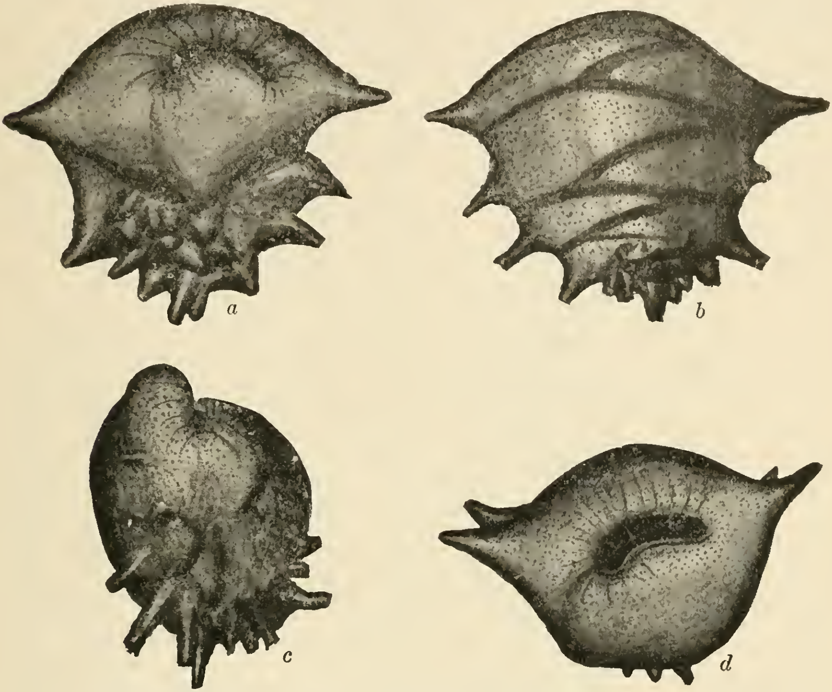


FIG. 156.—EHRENBERGINA HYSTRIX. × 40. *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW; *d*, APERTURAL VIEW.

The *Challenger* records for this species are all from the South Pacific, in rather deep water. This species is much more robust than the preceding; the shorter and stouter spines and the broad last formed chamber with its ornamentation of radial lines and the shape of the aperture are all very different from the conditions seen in *E. serrata*.

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Bulletin 71

A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN

Part III. LAGENIDÆ

BY

JOSEPH AUGUSTINE CUSHMAN
Of the Boston Society of Natural History

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Issued December 12, 1913.

INTRODUCTION.

The present volume is the third of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the family Lagenidæ. The first part, issued in 1910, included the families Astrorhizidæ and Lituolidæ. The second part, issued in 1911, included the family Textulariidæ. The fourth part will be devoted to the Chilostomellidæ, Globigerinidæ and Nummulitidæ, and further volumes will take up the remaining families of the Foraminifera as they are represented in the North Pacific.

Joseph Augustine Cushman.

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

LAGENIDÆ.

By Joseph Augustine Cushman,
Of the Boston Society of Natural History.

INTRODUCTION.

This third part of the work on the North Pacific Foraminifera deals entirely with the Lagenidæ, a family following in natural sequence those families already considered in the two earlier parts. The same arrangement of data is here adopted.

The treatment of the Lagenidæ will be found perhaps more conservative than that adopted in the earlier parts. This is due mainly to the much greater amount of work that has been done on this family by students of the Foraminifera. The Lagenidæ have seemingly always been a favorite with workers on the group, and the amount of literature is far greater than that on the families thus far considered.

There have been a number of works treating of the genus *Lagena* alone, and it has therefore been unnecessary to describe any great number of new species. The recent publication of Mr. Sidebottom on *Lagena*[1] has been of great assistance.

With the working out of the distribution of various species the faunal areas of the North Pacific have become more clearly defined. The number of species found at some stations of the United States Bureau of Fisheries steamer *Albatross*, off southern Japan, which are recorded by Brady from off the Philippines, is very considerable.

In addition to determining restrictions of range it has been possible to greatly extend the known range of certain species.

In this part, in addition to the data given in the other parts, the bottom temperature record of the station has been given in many cases. With certain species this seems to have a definite bearing on the distribution.

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[1] Journ. Quekett Micr. Club, vol. 11, 1912.

A systematic presentation of the various groups of the family follows:

Family 5. LAGENIDÆ.

Test calcareous, vitreous, finely perforate; either monothalamous or made up of a series of chambers arranged in a straight or curved axis, or close coiled or spirally, or even in an alternating manner; aperture either radiate or simple, with a neck and phialine lip.

The Lagenidæ form one of the most distinctive groups of the Foraminifera and its members are readily recognized. Usually the genus *Lagena*, making up the subfamily Lagenidæ, has been taken as the radicle from which the other genera have been derived. Species like *L. globosa* probably come as near a primitive radicle for this family as it is possible to determine.

From *Lagena* the simplest step in development is a series of such chambers as is seen in *Nodosaria*. On the other hand this series may become coiled as in *Cristellaria*. With these two genera as the base all the genera of the subfamily Nodosariinæ may be definitely assigned to one or the other groups. With *Nodosaria* belong such genera as *Lingulina* and *Triplasia* and with *Cristellaria* as reversionary forms, *Marginulina*, *Vaginulina*, and *Frondicularia*.

With the subfamily Polymorphininæ a distinct mode of development is instituted, an alternating subspiral arrangement being introduced, usually accompanied by a radiate type of aperture.

In the subfamily Uvigerininæ there is again a spiral arrangement, much more definite in its characters and the aperture typically has a long neck and phialine lip.

In the subfamily Ramulininæ the method of growth is very irregular and a mass of stolon-like tubes results.

In various genera microspheric and megalospheric forms occur and as usual the microspheric form holds longest to the earlier developmental stages. These stages tend to show that many of the genera have been derived from a coiled ancestral type, although in the megalospheric form this is not so definitely shown.

The Lagenidæ are richly ornamented and the range includes costæ, spines, wing-like plates as well as complicated surface patterns, especially well developed in the genus *Lagena*. The various combinations of surface ornamentation, together with the delicacy of form and curves that appear throughout the group make the Lagenidæ by far the most interesting of the various groups of the Foraminifera.

Although some forms are found in shallow water, the best development of the Lagenidæ takes place in waters from 50 to 500 fathoms in depth. *Lagena* is found in perhaps greater numbers between 1,000 and 2,000 fathoms as far as the North Pacific material shows. Warmer waters are necessary for the best development of *Cristellaria*, *Nodosaria*, etc.

Subfamily 1. LAGENINÆ.

Test consisting of a single chamber, the aperture either ecto- or entosolenian.

This subfamily includes the single genus *Lagena*.

Genus LAGENA Walker and Boys, 1784.

Lagena Walker and Boys (type, *L. globosa* (Montagu)), Test. Min., 1784, p. 3.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 440.

Description.—Test monothalamous, smooth or ornamented, generally flask-shaped, aperture ecto- or entosolenian.

The genus *Lagena* is one of the largest in point of view of numbers of described species and varieties of any of the genera of the Foraminifera. The opinion as to the limits of variation in the group varies with nearly every student of the group. In the material I have examined I have again and again been made aware of the similarity, even the almost identical character of ornamentation in specimens from widely separated stations, but usually in the same faunal area. Then, too, there must be recognized a considerable amount of variation in the group as well. The whole problem of *Lagena* is a very puzzling one, but the greater the amount of material from a given area the more definite these limits of variation seem. With a large series of specimens from a given faunal area it would seem that the limits of variation might be rather definitely fixed and a more orderly system brought out of the present somewhat chaotic condition.

In describing the various species and varieties of *Lagena* a general scheme has been adopted of keeping those species together which have similarities of ornamentation. In this way they may be most easily grouped, and this has been the method usually followed by previous writers.

On the basis of the aperture various names have been used in a generic sense, such as *Entosolenia*, *Fissurina*, *Phialina*, and so on, and on the basis of form many others have been used. The value of these groupings can only be tested by the study of large series as has already been suggested.

I have not tried to make the synonymy in any sense complete, as the whole literature in regard to the genus is in such a chaotic state. The following species and varieties have been recognized from the North Pacific:

LAGENA GLOBOSA (Montagu).

Plate 4, fig. 2.

"Serpula (Lagena) laevis globosa" Walker and Boys, Test. Min., 1784, p. 3, pl. 1, fig. 8.

Vermiculum globosum Montagu, Test. Brit., 1803, p. 523.

Lagena globosa Brown, Illus. Rec. Conch. Great Britain and Ireland, ed. 1, 1827, pl. 1, fig. 37; ed. 2, 1884, p. 126, pl. 56, fig. 37.—Reuss, Sitz. kais. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 318, pl. 1, figs. 1-3; Bull.

Acad. Roy. Belg., ser. 2, vol. 15, 1853, p. 143, pl. 1, figs. 13, 14.—JONES, PARKER, and H. B. BRADY, Pal. Soc. Mon., vol. 19, 1866, p. 32, pl. 1, fig. 32.—BUTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 197, pl. 7, fig. 2.—TERQUEM, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 26, pl. 1, fig. 7.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 170, pl. 2, fig. 3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 452, pl. 56, figs. 1–3.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 336.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 744, pl. 14, fig. 11.—HAEUSLER, Neues Jahrb. für Min., 1887, pt. 1, p. 181, pl. 4, figs. 1–4 (not 5–18).—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 221.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 477.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 323, pl. 10, fig. 69.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 77, pl. 13, fig. 741.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 27.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, pt. 4, 1897, p. 116, pl. 1, fig. 1.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 102, pl. 5, fig. 3.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 306, pl. 53, fig. 4.—KIAER, Rep. Norwegian Fish. Mar. Invest., vol. 1, No. 7, 1900, p. 39, pl., fig. 17.—MILLETT, Journ. Roy. Micr. Soc., 1901, p. 3.—RHUMBLER, Zool. Jahrb. Abth. Syst., vol. 24, 1906, p. 63.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 1.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 141.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 14.

Entosolenia globosa WILLIAMSON, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 16, pl. 2, figs. 13, 14; Rec. Foram. Great Britain, 1858, p. 8, pl. 1, figs. 15, 16.—DAWSON, Can. Nat., vol. 4, 1859, p. 28, figs. 4, 5; vol. 6, 1872, p. 254, pl. 3, fig. 2.

Lagena sulcata, var. (*Entosolenia*) *globosa* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 348, pl. 13, figs, 37*a*, *b;* pl. 16, figs. 10*a*, *b*.

Description.—Test subspherical, smooth, aperture either stellate or a fissure with an entosolenian neck, wall thin, usually transparent, but sometimes thicker and nearly opaque, white.

Length about 0.35 mm.; breadth usually a little less.

Distribution.—This species seems to be a cosmopolitan one and is well distributed in the North Pacific as elsewhere. Nearly all the stations are in deep water, but a few are in shallow depths and near shore in the case ot the record of Rhumbler off the Chatham Islands and Brady from the coral reefs of Honolulu.

A great many very variable figures are found if one looks up the synonymy of this species. According as the author's idea of variation has been restricted or loose the number of things put here varies. Perhaps the worst example of the latter is that of Parker and Jones.[1]

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[1] Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, pl. 11, figs. 25–29, where four figures referred to this species are four distinct species not one of which can be in any sense truly referred to this species with a smooth test. Brady's specimen from the Silurian as figured might be fully as well and perhaps better some form of *Difflugia* than *Lagena globosa*.

Balkwill and Wright, 1885, make note of two forms occurring in their material, one with a stellate aperture the other with a fissure. With a large collection of material various forms would doubtless be found which are perhaps of varietal rank and definitely distributed.

LAGENA OVUM (Ehrenberg).

Plate 2, fig. 2.

Miliola ovum Ehrenberg, Berlin Monatsber., 1843, p. 166; Mikrogeologie, 1854, pl. 23, fig. 2; pl. 29, fig. 45; pl. 31, fig. 4.

Lagena ovum Marsson, Mitth. nat. Ver. Neu-Vorpom. Rügen, Jahrg. 10, 1878, p. 120, pl. 1, fig. 1.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 454, pl. 56, fig. 5.

Description.—Test elongate, elliptical in front view, nearly circular in cross section, slightly compressed, ends broadly rounded, nearly equal; wall thin, transparent, smooth; aperture broadly elliptical, central, with a comparatively short entosolenian neck.

Length 0.4 mm.; breadth 0.2 mm.

Distribution.—Brady records this species from a single *Challenger* station in the North Pacific, in 2,300 fathoms. Specimens apparently referable to this species have occurred at three *Nero* stations, 1129 in 1,505 fathoms between Guam and Yokohama, 2049 in 2,226 fathoms, and 2064 in 1,355 fathoms, both off the Hawaiian Islands.

Ehrenberg's figures referred to *Miliola* are rather crude and indeterminate to which to assign this recent species, and it may be questioned whether this is a wholly satisfactory disposal of these almost elliptical forms.

LAGENA LÆVIS (Montagu).

Plate 1, fig. 3; plate 38, fig. 5.

"Serpula (Lagena) lævis ovalis" Walker and Boys, Test. Min., 1784, p. 3, pl. 1, fig. 9.

Vermiculum læve Montagu, Test. Brit., 1803, p. 524.

Lagenula lævis Fleming, Brit. Anim., 1828, p. 235.

Lagena lævis Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 12, pl. 1, figs. 1, 2.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 455.—Jones, Quart. Journ. Geol. Soc., vol. 40, 1884, p. 769, pl. 34, fig. 3 [?].—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 744, pl. 14, fig. 13.—Haeusler, Neues Jahrb. für Min., pt. 1, 1887, p. 181, pl. 4, figs. 31–49.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 4, vol. 10, 1890, p. 466, pl. 1, fig. 1.—Mariani, Boll. Soc. Geol. Ital., vol. 10, 1891, p. 725, pl. 21, fig. 9.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 478.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 3, 1893, p. 431, pl. 2, fig. 1.—Chapman, Journ. Roy. Micr. Soc., 1893, p. 581, pl. 8, fig. 5.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 74, pl. 13, figs. 719–722.—Egger, Jahrb. 16, Nat. Ver. Passau, 1895, p. 24, pl. 2, fig. 11.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 51.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1898, p. 210, pl., fig. 19.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 21, 1899, p. 102, pl. 5, fig. 2.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 306, pl. 53, fig. 6.—Wright, in Meade, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 12.—Silvestri, Mem. Pont. Accad. Nuovi Lincei, vol. 17, 1900, p. 244, pl. 6, fig. 56.—Millett, Journ. Roy. Micr. Soc., 1901, p. 9.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 141.

Miliola lævis Ehrenberg, Mikrogeologie, 1854, pl. 26, fig. 2; pl. 31, fig. 5.

Ovulina clava Ehrenberg, Mikrogeologie, 1854, pl. 32, II, fig. 2*b*.

Lagena vulgaris Williamson, Rec. For. Great Britain, 1858, p. 4, pl. 1, figs. 5, 5*a*.—Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862, p. 321, pl. 1, fig, 15; pl. 2, figs. 16, 17.

Lagena sulcata, var. *lævis* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 349, pl. 13, fig. 22; pl. 16, fig. 9*a*.

Description.—Test in front view oval, elliptical, or nearly circular, with a more or less elongate neck, in cross section subcircular; wall smooth, usually transparent; aperture at the end of the elongate neck, which often has a phialine lip.

Length up to 0.8 mm.; diameter up to 0.4 mm.

Distribution.—This species from the records would seem to be very common everywhere in the present oceans and in all the geological formations in which Foraminifera occur, but in the North Pacific material examined the species has occurred but a few times. Brady records it from several stations, but none of the figures in the *Challenger* report represent the typical species, and most of them may be referred to other things. All the specimens I have had came from the *Nero* and *Albatross* material dredged off Japan and between there and Guam, in 437 to 2,250 fathoms. Bagg records it from off the Hawaiian Islands and Goës from the western coast of America.

The synonymy of this species is interesting, including a very great range of things, some smooth, others striate, hispid, and variously ornamented, and in form a great many varied shapes are placed here. Without the original material it is useless to try to straighten out this perplexity of figures, as some of them in the older works are more or less conventionalized.

It is interesting to note the lack of records for this species in some of the works of more careful students. From this and my own experience the question of the very general distribution of this species may be raised.

LAGENA ACUTA (Reuss).

Plate 38, fig. 6.

Fissurina acuta Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 340, pl. 7, figs. 90, 91.

Lagena acuta Fornasini, Boll. Soc. Geol. Ital., vol. 7, 1888, p. 47, pl. 3, fig. 6.

Description.—Test somewhat elongate, compressed, in front view pyriform, broadest toward the aboral end, tapering gradually to the bluntly pointed apertural end, aboral end with an acutely pointed tip, more or less prominent, wall smooth, aperture elongate elliptical, extending to the central chamber by a fairly long neck.

Length about 0.75 mm.

Distribution.—This species seems to be rare in the North Pacific, having been noted but once in the material examined, *Nero* station 10, in 2,098 fathoms, west of the Hawaiian Islands.

This seems to be distinct from the form here referred to *L. sacculus* Fornasini, as the outline is more nearly that of the figures given by Reuss and the exterior is very smoothly sloping without an accentuation of the central chamber as in the species *L. sacculus*.

LAGENA LÆVIGATA (Reuss).

Plate 2, fig. 1.

Fissurina lævigata Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 366, pl. 46, fig. 1; Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 338, pl. 6, fig. 84.—Terquem, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 30, pl. 1 (9), figs. 17 *a*, *b*.

Lagena lævigata Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 177, pl. 1, fig. 6.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 473, pl. 114, figs. 8 *a*, *b*.—Blackwill and Millett, Journ. Micr., vol. 3, 1884, p. 81, pl. 2, fig. 6.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 330, pl. 10, figs. 64, 65.—Madsen, Medd. fra Dansk. Geol. Forening, No. 2, 1895, pp. 74, 195, pl., fig. 3.—Millett, Journ. Roy. Micr. Soc., 1901, p. 493.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 5, pl. 1, fig. 6 [?].

Fissurina globosa Bornemann, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 317, pl. 12, fig. 4.

Lagena marginata Haeusler, Neues Jahrb. für Min., 1887, pt. 1, p. 186, pl. 4, figs. 51, 52 (not *Vermiculum marginatum* Montagu).

Description.—Test subglobose, compressed, somewhat pyriform in front view, in cross section elliptical; wall smooth, transparent in thin specimens or opaque in more thickened ones, along the lateral margins usually clear even in thickened specimens; aperture elongate, fairly narrow, connecting with the interior by a fairly long entosolenian neck.

Length up to 1 mm.; breadth slightly less.

Distribution.—Brady records this species at four *Challenger* stations in the western and middle North Pacific from 1,850 to 3,125 fathoms in depth. In the material which I have examined it has occurred at many *Nero* and *Tuscarora* stations from the Hawaiian Islands to Japan, the depths varying from 1,186 to 2,086 fathoms.

This species is common everywhere from existing records, yet fails to appear as would be expected in lists from certain regions. This may be due to the fact that the figure in the *Challenger* Report was not placed on the plates with the others but is near the end of the volume and may have been overlooked.

LAGENA SACCULUS Fornasini.

Plate 3, figs. 1–3.

Lagena acuta H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 474, pl. 59, figs. 6*a*, *b* (not *L. acuta* (Reuss)).

Lagena acuta, var. *sacculus* Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 9, 1901, p. 49, fig. 3.

Description.—Test usually somewhat carinate, body of test in front view nearly circular, in end view broadly elliptical, neck somewhat variable in length and breadth, but varying correspondingly with the development of the carina, which may be very slight or rather well developed according to the specimen; wall smooth, fairly thick, either transparent and distinctly punctate or thickened and nearly opaque, aboral end of test extending out into an acute angled process; aperture at the exterior elongate, elliptical, with a well-developed entosolenian neck extending well into the central cavity of the test, usually with the inner end somewhat expanded, carina when well developed often showing radial lines formed by punctæ extending in from its periphery.

Length up to 0.6 mm.

Distribution.—Well distributed in the *Nero* material from the region west of the Hawaiian Islands to Guam and the coast of Japan. The depths of the stations at which this species was taken vary from 1,088 to 2,225 fathoms, most of the stations being more than 1,500 fathoms in depth. There are records for two *Challenger* stations, 241 in 2,300 fathoms and 244 in 1,850 fathoms, both east from Japan.

This is one of the species in which a definite variation seems to occur. In the specimen figured by Fornasini there is little if any keel developed and the external neck is very short and broad. From this the variation is through a series increasing the breadth of the carina and at the same time increasing the length of the neck until in such specimens as that figured by Brady and again in my figure (fig. 3) there is a broad fairly thin keel and a relatively long neck. Throughout the series, however, there is the same shape to the body of the test, circular in front view and broadly elliptical in end view; the external aperture remains elliptical and the entosolenian neck of the same general shape and of fairly uniform length.

Reuss's figure of *Fissurina acuta* shows a specimen with a much more elongate body and an acute apertural end, the whole outline considerably different from our recent specimens, and apparently Fornasini is right in segregating this form from that described by Reuss. Even Brady questioned the identity of the two.

LAGENA CLAVATA (d'Orbigny).

Plate 2, fig. 3.

Oolina clavata D'ORBIGNY, For. Foss. Vienne, 1846, p. 24, pl. 1, fig. 2.

Lagena clavata MACKIE, Recreative Science, vol. 1, 1859, p. 148, fig. 13.—REUSS, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 320, pl. 1, figs. 13, 14.—TERQUEM, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 25, pl. 1 (9), fig. 2.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 456.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 324, pl. 10, fig. 68.—HAEUSLER, Abh. schweiz. Pal. Ges., vol. 20, 1893, p. 14, pl. 1, figs. 17–22.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 75, pl. 13, figs. 725–727.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, pt. 4, 1897, p. 116, pl. 1, fig. 2.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1897 (1898), p. 14 (206), pl., fig. 18.—WRIGHT, in Meade, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 13.—MILLETT, Journ. Roy. Micr. Soc., 1901, p. 490.

Lagena lævis, var. *amphora* WILLIAMSON, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 12, pl. 1, figs. 3, 4.

Lagena lævis HAEUSLER, Neues Jahrb., 1887, pt. 1, p. 181, pl. 4, figs. 39–48; Abh. schweiz. Pal. Ges., vol. 17, 1890, p. 86, pl. 13, figs. 17, 18.

Lagena vulgaris, var. *clavata* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 5, pl. 1, fig. 6.

Lagena lævis, var. *clavata* WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 478.

Description.—Test elongate, clavate or fusiform, with a long neck at the oral end and an elongation of the test somewhat variable in length at the aboral end, surface smooth, cross section nearly circular, wall thin and transparent, aperture nearly circular, at the end of the neck, often with a phialine lip.

Length up to 1 mm.

Distribution.—Apparently this species is not definitely recorded from the North Pacific. The only material I have had referable to this species was from *Nero* station 1466 in 234 fathoms near Guam.

LAGENA LATERALIS, new species.

Plate 1, fig. 1.

Description.—Test elongate, somewhat compressed, broadest toward the basal end, apertural end somewhat tapering, both ends broadly rounded, the basal end somewhat truncate, end view oval; wall smooth, transparent or nearly so, the flattened sides closely set with punctæ, the lateral margins without punctæ, aperture lateral, at one side below the apex, elongate, elliptical with lip-like margins, with a long entosolenian neck more than half the length of the test, flaring at its inner end.

Length about 0.45 mm.; broadest diameter about 0.2 mm.

Distribution.—Type-specimen, Cat. No. 8524, U.S.N.M., from *Albatross* D4974 in 905 fathoms off Yokohama, Japan. Specimens also occurred at several *Nero* stations and one *Tuscarora* station between Guam and Yokohama in 660 to 2,104 fathoms. There was little variation observed in the specimens from these six stations.

The specimens figured by Brady[1] may very probably belong to this species. They have the broad-lipped aperture at one side of the axis while Reuss's examples of *L. apiculata* have a definite stellate aperture.

LAGENA COLLARIS, new species.

Plate 1, fig. 2.

Description.—Test elongate, ovoid in front view, widest near the aboral end, apertural end with a deep constriction somewhat in from the actual end; cross section circular, wall thin, transparent, smooth; aperture nearly circular, opening into a separate cavity which connects with the larger part of the test by a short entosolenian tube.

Length 0.35 mm.; breadth 0.2 mm.

Distribution.—Type-specimen, Cat. No. 8525, U.S.N.M., from *Nero* station 1147 in 1,856 fathoms, midway between Yokohama and Guam.

The external constriction in the test seems to really mark the apex of the test and the small portion above is a supra-added chamber-like portion of the test with its own aperture to the exterior. From the level of the constriction or slightly above there is a short entosolenian tube passing downward into the main cavity of the test.

LAGENA FELSINEA Fornasini.

Plate 4, fig. 1.

Lagena vulgaris, var. (*Entosolenia*) *globosa* Rymer-Jones, Trans. Linn. London, vol. 30, 1872, pl. 19, fig. 2 (not *L. globosa* (Montagu)).

Lagena apiculata H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 56, fig. 4.

Lagena emaciata, var. *felsinea* Fornasini, Mem. Accad. Ist. Bologna, ser. 5, vol. 9, 1901, p. 47, fig. 1.

Description.—Test elongate; subcylindrical, arcuate in side view especially toward the apertural end, aboral end broader, rounded or slightly acute; wall thin, smooth, aperture eccentric, rounded, with a long entosolenian neck somewhat inflated at its inner end.

Length about 0.7 mm.; diameter about 0.25 mm.

Distribution.—Specimen figured from *Nero* station 1012 in 1,932 fathoms between Guam and Japan. The specimen figured by Rymer-Jones was from the region of Java. Fornasini's original specimen is from the Mediterranean region.

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[1] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 56, figs. 17, 18.

LAGENA GRACILLIMA (Seguenza).

Plate 1, fig. 4.

Amphorina gracilis Costa, Atti Accad. Pontiniana, vol. 7, 1856, p. 121, pl. 11, fig. 11.

Amphorina gracillima Seguenza, Foram. mon. Mioc. Messina, 1862, p. 51, pl. 1, fig. 37.

Lagena gracillima Jones, Parker, and H. B. Brady, Pal. Soc. Mon., vol. 19, 1866, p. 45, pl. 1, figs. 36, 37.—H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 292, pl. 11, figs. 6*a–c*.—Butschli, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 197, pl. 7, fig. 20.—Fornasini, Boll. Soc. Geol. Ital., vol. 2, 1883, p. 185, pl. 2, fig. 5.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 456, pl. 56, figs. 21, 22, 24–26 [19? 20? 23? 27? 28?].—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 330, pl. 10, fig. 12.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 75, pl. 13, fig. 729 (not 728, 730); Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 52.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 306, pl. 53, fig. 3.—Silvestri, Mem. Pont. Accad. Nuovi Lincei, vol. 17, 1900, p. 245, pl. 6, fig. 42.—Millett, Journ. Roy. Micr. Soc., 1901, p. 491.

Lagena sulcata, var. *distoma-polita* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 357, pl. 13, fig. 21; pl. 18, fig. 8.

Lagena lævis, var. *gracillima* Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 478.

Description.—Test much elongate, slender, broadest near the middle, thence tapering toward either end and continued out into a long slender tubular neck at each end, apertural end with a definite rim at the apex when complete and the opposite end probably closed in perfect specimens, delicate, wall thin and hyaline, smooth; transparent.

Length up to 1.5 mm.

Distribution.—This species is recorded by Brady from three *Challenger* stations; 206 in 2,100 fathoms in the China Sea; 241 in 2,300 fathoms east of Japan; and 232 in 345 fathoms on the *Hyalonema*-ground south of Japan. Goës records it from three *Albatross* stations off the west coast of America in 782, 1,132, and 1,832 fathoms. In the material I have had the species has occurred in these same two regions, *Albatross* D4775 in 584 fathoms and D4964 in 37 fathoms, both off Japan, and *Tuscarora* station 9, in 980 fathoms off southern California.

Although this species is usually described as having an aperture at both ends it seems to me that this is accidental, and that in perfect specimens the aboral end will be found to be closed. Owing to the extreme tenuity of the ends and the fragile character of the wall, the perfect aperture with its prominent lip is seen in but a small per cent of the specimens examined. This is apparently due to breakage in handling the material. The same is probably true of the aboral end, for no trace of a lip or other indication of a finished end is noted either in specimens or figures of this species. The complete apertural end is shown in the accompanying figure and in the figure given by Parker and Jones (pl. 18, fig. 8). There may be gradations between this species and *Lagena elongata*, but as far as seen *L. gracillima* has the main portion of the test decidedly fusiform, while in *L. elongata* the sides are usually nearly parallel for a considerable portion of their length.

The specimen figured by Flint, which in his figure (pl. 53, fig. 3) is shown as the second specimen from the left side, is the most perfect I have seen and shows the perfect apertural lip and the almost perfect aboral end terminating in a very delicately pointed tip. Some of the other specimens in this set had perhaps best be referred to *L. elongata*.

LAGENA ELONGATA (Ehrenberg).

Plate 1, fig. 5.

Miliola elongata Ehrenberg, Bericht preuss. Akad. Wiss. Berlin, 1844, p. 274, 1845, p. 371; Mikrogeologie, 1854, pl. 25, fig. 1.

Lagena elongata Tate and Blake, Yorkshire Lias, 1876, p. 454, pl. 18, figs. 9, 9*a*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 457, pl. 56, fig. 29.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 75, pl. 13, fig. 731.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 306, pl. 53, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1901, p. 492, pl. 8, fig. 10.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 91.

Lagena gracillima (part) H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 56, figs. 27, 28.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, pl. 13, figs. 728, 730 (not 729).

Lagena vulgaris, var. *distoma-polita* Rymer-Jones (part), Trans. Linn. Soc. London, vol. 30, 1875, p. 64, pl. 19, fig. 55.

Description.—Test much elongate, slender, middle portion cylindrical tapering gradually into slender tubular projections at either end, apertural end when complete with a slightly projecting lip; wall thin and hyaline, smooth; transparent.

Length up to 2.5 mm.

Distribution.—This species does not seem to be recorded from the North Pacific. I have found specimens in but two regions in the material I have examined, *Albatross* H4025 in 536 fathoms in Bering Sea and several stations off Japan, depths varying from 44 to 649 fathoms, average 308 fathoms, and bottom temperatures varying from 38.1° F. to 39.9° F. In none of these cases was *L. gracillima* present.

As usually considered, this species is cylindrical in the middle, with nearly parallel sides for a considerable distance, instead of fusiform from the middle as in *L. gracillima*. In rare cases the apertural lip seems to be preserved, but usually specimens are broken close back to the stouter cylindrical portion.

The original figure given by Ehrenberg is a rather poor one, but may be this species. Egger's figure[1] has prominent lines of punctæ which are not typical of this species, and apparently does not belong here.

LAGENA APICULATA (Reuss).

Oolina apiculata Reuss, in Haidinger's Nat. Abhandl., vol. 4, 1850, p. 22, pl. 1, fig. 1.

Lagena apiculata Reuss, Sitz. Akad. Wiss. Wien, vol. 46, 1862 (1863), p. 319, pl. 1, figs. 4–8, 10, 11.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 453, pl. 56, figs. 4, 15–18.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 80, pl. 13, fig. 747.—Sidebottom, Journ. Quekett Micr. Soc., vol. 11, 1912, p. 381, pl. 14, figs. 16–18.

Description.—Test subglobose, smooth, entosolenian, but slightly if at all compressed, apical end with a pointed spine, variable in length. Length 0.5 mm.

Distribution.—This species is recorded in the Summary of Results of the *Challenger* Report at stations in the western Pacific down to 2,300 fathoms. I have had a specimen from *Nero* station 1155 in 1,652 fathoms between Guam and Yokohama.

LAGENA HISPIDA Reuss.

Plate 4, figs. 4, 5; plate 5, fig. 1.

"Sphaerulæ hispidæ" Soldani, Testaceographia, vol. 2, 1798, p. 53, pl. 17, figs. V, X.

Lagena hispida Reuss, Zeitschr. deutsch. geol. Ges., vol. 10, 1858, p. 43; Sitz. Akad. Wiss. Wien, vol. 46, 1863, p. 335, pl. 6, figs. 77–79.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 459, pl. 57, figs. 1–4; pl. 59, figs. 2, 5.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 324, pl. 10, fig. 26.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 307, pl. 53, fig. 8.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 141.—Sidebottom, Journ. Quekett Micr. Soc., vol. 11, 1912, p. 385, pl. 14, fig. 31; pl. 15, figs. 1, 2.

Description.—Test variously formed, globular to pyriform, the surface clothed with delicate spines uniformly distributed over the test. Length 0.4 to 0.8 mm.

Distribution.—Brady records this species at a single *Challenger* station in the North Pacific off Japan in 345 fathoms. Bagg records it from the vicinity of the Hawaiian Islands, *Albatross* station H4585 in 689 fathoms. I have material from *Nero* station 2037 in 55 fathoms off the Hawaiian Islands, 1147 in 1,856 fathoms and *Albatross* D4891 in 181 fathoms, both off Japan.

Figures are here given of two of the modifications noted, the globose form with long tubular projection (pl. 4, fig. 5) and the compressed form (pl. 4, fig. 4) noted by Sidebottom.

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[1] Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, pl. 10, fig. 14.

LAGENA HISPIDULA, new species.

Plate 5, figs. 2, 3.

Lagena lævis H. B. Brady (part) (not *L. lævis* (Montagu)), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 56, figs. 10, 11.

Description.—Test flask-shaped, broadly rounded at the base, abruptly narrowed above into a long tubular neck, whole surface very finely and evenly hispid; aperture rounded.

Length 0.60 to 0.95 mm.

Distribution.—This species occurred in the North Pacific material off the Hawaiian Islands, *Nero* station 2049 in 2,226 fathoms, off Japan, *Albatross* station D4950 in 529 fathoms, bottom temperature 38.9° F., in Gaspar Straits, North Pacific Exploring Expedition, Captain Rodgers, and at several *Nero* stations along the line of soundings between Yokohama and Japan, as follows: 1137 in 2,250 fathoms; 1160 in 1,907 fathoms; 1163 in 2,049 fathoms; 1209 in 660 fathoms; 1264 in 2,080 fathoms (type-locality); 1306 in 1,208 fathoms and 1310 in 518 fathoms.

Type.—Cat. No. 8526, U.S.N.M.

This species, which has been included in *Lagena lævis*, has a very characteristic form and is as far as I have observed invariably hispid. In fact in selected material this form has been taken out first with a low-power lens on account of form alone, and has always been found hispid when examined with a higher-power lens. It seems worthy of being separated from the smooth, more pyriform *L. lævis.*

LAGENA AMPULLA-DISTOMA (Rymer-Jones).

Plate 14, fig. 7.

Lagena vulgaris Williamson, var. *ampulla-distoma* Rymer-Jones, Trans. Linn, Soc. London, vol. 30, 1872, p. 63, pl. 19, fig. 52.

Lagena ampulla-distoma H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 458, pl. 57, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1901, p. 5, pl. 1, fig. 5.—Sidebottom, Journ. Quekett Micr. Soc., vol. 11, 1912, p. 384.

Description.—Test subglobular, broadest slightly below the middle, apertural end broadly truncate with a raised rim about the aperture at some distance; apical end with an external tube usually somewhat curved; wall of the test rough granular.

Length 0.4 to 0.6 mm.

Distribution.—The only occurrence of this species in the North Pacific material examined is *Nero* station 2037 in 55 fathoms off the Hawaiian Islands.

LAGENA AMPULLA-DISTOMA (Rymer-Jones), var. CRIBROSTOMOIDES, new variety.

Plate 4, fig. 3.

Description.—Like the typical, but the aperture a sieve-like plate, with numerous small rounded openings, apical end with numerous spines as well as the apical tubular projection.

Length 0.4 mm.

Distribution.—Type-specimen, Cat. No. 8527, U.S.N.M., from *Nero* station 1310 in 518 fathoms between Guam and Yokohama.

This variety shows a rather unusual type of aperture for this genus.

LAGENA HYSTRIX Reuss.

Plate 5, fig. 5.

Lagena hystrix Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 335, pl. 6, fig. 80.

Lagena histrix Terquem, Mem. Soc. Geol. France, ser. 3, vol. 2, 1882, p. 28, pl. 1 (9), fig. 14; ser. 3, vol. 4, 1886, p. 7, pl. 1, fig. 7.

Description.—Test flask-shaped, somewhat compressed, broadest at about the middle, neck short; surface with spine-like tubes, open at the end, intermediate spaces punctate.

Length 0.5 mm.

Distribution.—Specimens which from their peculiar surface ornamentation seem to belong to this species occurred off Japan, *Nero* station 1294 in 1,417 fathoms and *Albatross* H4878 in 84 fathoms, bottom temperature 51.9° F.

A figure is given showing the surface view of the tubulations. These are apparently not broken spines, as suggested by Brady, but are a definitely developed surface character in the test of this species.

LAGENA PUNCTULATA, new species.

Plate 5, fig. 4.

Description.—Test flask-shaped, broadest below the middle, apical end rounded, apertural end gradually tapering to a short neck with a phialine lip; rounded in cross section; surface with an ornamentation consisting of an irregular series of large punctæ or fine pores, with the areas between finely punctate.

Length 0.4 mm.

Distribution.—Type-specimen, Cat. No. 8528, U.S.N.M., from *Albatross* station H4878 in 84 fathoms off Japan.

This species is perhaps related to *L. hystrix*, but the ornamentation consists of pores instead of spine-like tubulations.

LAGENA ASPERA Reuss.

Plate 16, fig. 1.

Lagena aspera Reuss, Sitz. Akad. Wiss. Wien, vol. 44, 1861, p. 305, pl. 1, fig. 5; vol. 46, 1863, p. 335, pl. 6, fig. 81.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 457, pl. 57, figs. 7–10.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 337, pl. 14, figs. 10–12.—Chapman, Journ. Roy. Micr. Soc., 1893, p. 582, pl. 8, fig. 8.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 325, pl. 10, fig. 11.

Description.—Test flask-shaped, usually globular with a short stout neck, surface ornamented with an irregularly placed series of beadlike blunt spines.

Length 0.6 mm.

Distribution.—Brady records this species from two *Challenger* stations in the North Pacific in 2,050 and 2,300 fathoms. I have seen it but once, from *Nero* station 172 in 2,086 fathoms near the Midway Islands and 1463 in 951 fathoms near Guam.

In this specimen there is a tendency for the ornamentation on the neck to be linear in its arrangement and a definite phialine lip is present.

LAGENA SQUAMOSA (Montagu).

Plate 6, fig. 1.

Vermiculum squamosum Montagu, Test. Brit., 1803, p. 526, pl. 14, fig. 2.

Entosolenia squamosa Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, pl. 2, fig. 19; Rec. For. Great Britain, p. 12, pl. 1, fig. 29.

Lagena squamosa Brown, Ill. Rec. Conch. Great Britain, 1827, pl. 1, fig. 32.—Jones, Parker, and H. B. Brady, Mon. For. Crag, 1866, p. 39, pl. 4, fig. 7.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 471, pl. 58, figs. 28–31.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 340, pl. 14, fig. 9.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 326, pl. 10, figs. 58, 59.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 79, pl. 13, fig. 745.

Entosolenia globosa, var. *squamosa* Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 278, pl. 11, fig. 25.

Description.—Test subglobular, broadly rounded at the apical end, bluntly pointed at the apertural end, surface reticulated, the apertural end of each areole being arched, giving the appearance of overlapping scales.

Length 0.25 to 0.50 mm.

Distribution.—I have had material of this species from the following North Pacific stations: *Tuscarora* 2, lat. 21° 07′ N.; long. 158° 14′ W., in 1,468 fathoms and 41, lat. 33° 38′ N.; long. 120° 38′ W., in 530 fathoms; *Nero* stations 201 in 1,033 fathoms near the Midway Islands and 1065 in 1,321 fathoms north of Guam; and *Albatross* station D4825 in 120 fathoms off Japan.

This species may be distinguished from *L. hexagona* and its varieties by the form of the reticulations.

LAGENA HEXAGONA (Williamson).

Plate 6, figs. 2, 3.

Entosolenia squamosa Montagu, var. *hexagona* Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 20, pl. 2, fig. 23; Rec. For. Great Britain, 1858, p. 13, pl. 1, fig. 31.

Lagena hexagona Siddall, Cat. Brit. Rec. For., 1879, p. 6.—Green, Amer. Journ. Micr., vol. 6, 1881, p. 46, pl., fig. 4.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 472, pl. 58, figs. 32, 33.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 326, pl. 10, fig. 60.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 17, pl. 2, fig. 3.

Description.—Test subglobular, broadly rounded at the apical end, bluntly pointed at the apertural end, surface ornamentation consisting of a reticulate pattern, the areoles of which are hexagonal, either arranged in vertical rows or irregular.

Length 0.25 to 0.50 mm.

Distribution.—I have had this species from the following North Pacific stations: *Nero* 1867 in 2,311 fathoms near the Midway Islands; 1603 in 1,733 fathoms and 1294 in 1,417 fathoms between Guam and Yokohama; and *Albatross* D4957 in 437 fathoms and D5054 in 282 fathoms off Japan.

In the specimens examined the arrangement of the reticulations seems usually to be very irregular, but occasionally it assumes vertical lines.

LAGENA HEXAGONA (Williamson), var. SCALARIFORMIS (Williamson).

Plate 6, fig. 4.

Entosolenia squamosa (Montagu), var. *scalariformis* Williamson, Rec. For. Great Britain, 1858, p. 13, pl. 1, fig. 30.

Lagena scalariformis Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 333, pl. 5, figs. 69–71.

Description.—Test similar in form to *L. hexagona* but differing in the surface ornamentation, which is elongate hexagonal, the vertical sides forming almost continuous costæ, the sides of the reticulations being thick.

Length 0.33 mm.

Distribution.—This form was noted at two North Pacific stations: *Tuscarora* 5, lat. 37° 04′ N.; long. 123° 22′ W., in 1,200 fathoms, and *Nero* station 201 in 1,033 fathoms near the Midway Islands.

LAGENA FOVEOLATA Reuss.

Plate 7, fig. 3.

Lagena foveolata Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 332, pl. 5, fig. 65.—Millett, Journ. Roy. Micr. Soc., 1901, p. 11, pl. 1, fig. 15.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 395, pl. 16, fig. 15.

Description.—Test pyriform, broadest toward the base, broadly rounded at the apical end, gradually tapering to the slender neck at the apertural end, surface ornamentation consisting of longitudinal raised costæ, the furrows between divided transversely by less well-developed transverse costæ.

Length 0.25 mm.

Distribution.—Specimens occurred at three *Nero* stations between Guam and Yokohama; 1065 in 1,321 fathoms, 1128 in 1,418 fathoms, and 1301 in 1,088 fathoms. The coarser of these is here figured. The other is much finer in its sculpturing. Both specimens are closer to Reuss's figure than those given by either Millett or Sidebottom.

LAGENA FOVEOLATA Reuss, var. PARADOXA Sidebottom.

Plate 15, fig. 3.

Lagena foveolata Reuss (?), var. *paradoxa* Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 395, pl. 16, figs. 22, 23.

Description.—Test flask-shaped, elongate, broad and rounded at the aboral end, tapering gradually toward the apertural end; neck short but definite; wall ornamented with longitudinal costæ running the entire length of the test, the inner costal furrows divided transversely by slightly raised lines and the whole furrow occupied by a double row of elongate, fine openings, outer wall tending to disintegrate and flake off, leaving the inner wall of the test exposed and spinose, the spines in longitudinal lines.

Length of North Pacific specimens 1.25 mm.

Distribution.—This variety was described from the southwest Pacific. This characteristic ornamentation and disintegration of the test is apparent in material from *Nero* station 2052 in 1,184 fathoms off the Hawaiian Islands.

LAGENA CATENULATA (Williamson).

Plate 7, figs. 1, 2.

Entosolenia squamosa Montagu, var. *catenulata* Williamson, Rec. Foram. Great Britain, 1858, p. 13, pl. 1, fig. 31.

Lagena catenulata Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 332, pl. 6, figs. 74, 75.

Description.—Test pyriform, nearly circular in transverse section or polygonal, surface ornamented with prominent longitudinal costæ, with a series of coordinate transverse costæ between, usually horizontal or slightly arched upward.

Length about 0.25 mm.

Distribution.—This species occurred at the following North Pacific stations: *Nero*, 1129 in 1,505 fathoms, and 1310 in 518 fathoms, between Guam and Yokohama; also at *Albatross* station, D4843 in 100 fathoms off Japan.

Although the original figure given by Williamson shows a surface ornamentation less regular in character than those figured here, nevertheless the general character is the same, the transverse and longitudinal costæ being practically of equal prominence and nearly at right angles with one another.

LAGENA STRIATA (d'Orbigny).

Plate 7, figs. 4, 5.

Oolina striata d'Orbigny, Foram. Amér. Mérid., 1839, p. 21, pl. 5, fig. 12.

Lagena striata Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 327, pl. 3, figs, 44, 45; pl. 4, figs. 46, 47.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 460, pl. 57, figs. 22, 24.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 327, pl. 10, figs. 21–23.

Description.—Test flask-shaped, nearly circular in cross section, body of test subglobular, neck variable in length, usually rather abruptly contracted from the body of the test at its base, surface ornamented with numerous rather fine costæ running the entire length of the test, apical end typically broadly rounded, occasionally slightly tapering to a point.

Length 0.25 to 0.75 mm.

Distribution.—Bagg records this species from three *Albatross* stations: H4566 in 572 fathoms, H4567 in 1,307 fathoms, and H4694 in 865 fathoms off the Hawaiian Islands. I have had material from *Nero* station, 2049 in 2,226 fathoms off the Hawaiian Islands, 1309 in 891 fathoms between Guam and Yokohama, and at three *Albatross* stations—D4900 in 139 fathoms, D4958 in 405 fathoms, and D5056 in 258 fathoms, all off Japan.

There are many forms of striate Lagenæ, and it is very uncertain from the material I have had at my disposal where to draw lines of demarcation between forms. Unless there have been definite characters which have had some appearance of stability, I have preferred to place them under *L. striata.* Certain other forms have occurred in some numbers and have had rather definite characters, and for these certain names have been used to distinguish them here.

LAGENA STRIATA (d'Orbigny), var. HAIDINGERI (Czjzek).

Plate 7, fig. 6.

Oolina haidingeri Czjzek, Haidinger's Nat. Abhandl., vol. 2, 1847, p. 138, pl. 12, figs. 1, 2.

Lagena haidingeri Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 326, pl. 3, fig. 41.

Lagena striata H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 57, figs. 29, 30.—Sidebottom (part), Journ. Quekett Micr. Club, vol. 11, 1912, pl. 15, fig. 9.

Description.—Variety differing from typical *L. striata* in the neck, which is subconical with several prominent platelike costæ and the apical end with numerous short spines, usually curved outwardly.

Length 0.65 mm.

Distribution.—This variety was obtained at *Albatross* station, D2806 in 1,379 fathoms off the Galapagos Islands.

The two added characters of a fluted truncate conical neck with the basal outwardly curving spines seem to be correlated and the form worthy of recognition.

LAGENA STRIATA (d'Orbigny), var. SUBSTRIATA Williamson.

Plate 8, figs. 1–3.

Lagena substriata Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 15, pl. 2, fig. 12.

Lagena vulgaris, var. *substriata* Williamson, Rec. For. Great Britain, 1858, p. 7, pl. 1, fig. 14.

Description.—Variety differing from the typical in the more elongate body, long tapering neck, costulate surface extending up onto the neck often to its end and usually spirally arranged on the neck.

Length 0.4–0.5 mm.

Distribution.—This variety seems to be much more common in the North Pacific than the others. It occurred at *Tuscarora* station 9 in lat. 31° 51′ N.; long. 119° 3′ W., in 980 fathoms. It has also occurred at numerous *Albatross* and *Nero* stations off Japan in depths ranging from 33 to 1,529 fathoms, but one station, however, being over a thousand fathoms.

LAGENA STRIATA (d'Orbigny), var. STRUMOSA Reuss.

Plate 7, figs. 7–10.

Lagena strumosa Reuss, Zeitschr. geol. Ges., 1858, p. 434; Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 328, pl. 4, fig. 49.

Description.—Test clavate, body portion subglobular or slightly fusiform, ornamented with numerous longitudinal costæ, the apical end prolonged into a stout spine; neck long and comparatively stout, ending in a phialine lip, which is itself prominently costate, neck ornamented with raised annuli either transversely costate or beaded and sometimes spinose between the annuli.

Length up to 0.6 mm.

Distribution.—This is again one of the most common varieties of this species, especially in the material from off the coast of Japan. Near the Midway Islands it occurred at *Nero* station 105 in 2,370 fathoms, between the Midway Islands and Guam at *Nero* station 542 in 1,996 fathoms, between Guam and Yokohama at *Nero* stations 1209 in 660 fathoms and 1301 in 1,088 fathoms. It occurred at several *Albatross* stations off Japan, the depths ranging from 84 to 440 fathoms.

LAGENA COSTATA (Williamson).

Plate 9, fig. 6; plate 10, fig. 1; plate 12, fig. 1.

Entosolenia costata Williamson, Rec. For. Great Britain, 1858, p. 9, pl. 1, fig. 18.
Lagena costata Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 329, pl. 4, fig. 54.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 338, pl. 14, figs. 10–12.—Millett, Journ. Roy. Micr. Soc., 1901, p. 7, pl. 1, fig. 8.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 388, pl. 15, figs. 16–20.

Description.—Test subglobular ornamented with a few rather remote ribs or costæ running nearly the length of the test, frequently not reaching the apex, but ending in a ring of spinose projections, aperture small and rounded; costæ most often rounded.

Length 0.25 to 0.50 mm.

Distribution.—I have had this species from *Nero* station 165 near the Midway Islands in 2,135 fathoms, between Guam and Yokohama, *Nero* stations 1065 in 1,321 fathoms, and 1306 in 1,208 fathoms, and *Albatross* station D4875 in 59 fathoms off Japan.

LAGENA COSTATA (Williamson), var. AMPHORA Reuss.

Plate 10, figs. 2, 3; plate 12, fig. 2.

Lagena amphora Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 330, pl. 4, fig. 57.

Description.—Test elongate pyriform with a long tapering neck; surface with comparatively few, prominent costæ; aperture small, rounded.

Length 0.4–0.6 mm.

Distribution.—This variety was found at the following stations: *Tuscarora* 9, lat. 31° 51′ N.; long. 119° 3′ W., in 980 fathoms; *Tuscarora* 40, lat. 33° 41′ N.; long. 120° 50′ W., in 1,092 fathoms; *Nero* 542 in 1,996 fathoms between the Midway Islands and Guam; at several *Nero* stations between Guam and Yokohama at depths ranging from 891 to 1,632 fathoms; and two *Albatross* stations off Japan, D4825 in 120 fathoms and D4843 in 100 fathoms.

In this form there is much variation in the number of costæ and in the form as shown in the specimens here figured.

LAGENA COSTATA (Williamson), var. POLYGONATA, new variety.

Plate 10, fig. 4.

Description.—Test subglobular, apertural end somewhat reduced, base truncate, polygonal in transverse section, angles reduced into longitudinal costæ; apical end with a polygonal depression at which the costæ end; aperture rounded.

Length 0.50 to 0.85 mm.

Distribution.—Type-specimen from *Nero* station 173 in 2,111 fathoms southeast of the Midway Islands. It also occurred at *Nero* station 1294 in 1,417 fathoms north of Guam.

Type.—Cat. No. 8529, U.S.N.M.

LAGENA DISTOMA Parker and Jones.

Plate 13, figs. 1, 2.

Lagena lævis (MONTAGU), var. *striata* PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 278, pl. 11, fig. 24 (not *L. striata* (Walker and Boys)).

Lagena distoma PARKER and JONES in H. B. Brady, Trans. Linn. Soc. London, vol. 24, 1864, p. 467, pl. 48, fig. 6.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 461, pl. 58, figs. 11–15.—EGGER, Abh. kön. bay. Wiss. München, Cl. II, vol. 18, 1893, p. 330, pl. 10, fig. 13.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 53.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 306, pl. 53, fig. 5.

Description.—Test elongate subcylindrical or elongate fusiform, tapering at either end, wall longitudinally striate; translucent.

Length 1 to 2 mm.

Distribution.—Brady records this species in the North Pacific from a single *Challenger* station off Japan in 345 fathoms. Goës records it from the eastern Pacific in 782 to 1,132 fathoms. I have had material from three stations off Japan; *Nero* stations 1305 in 1,289 fathoms and 1309 in 891 fathoms; and *Albatross* D4843 in 100 fathoms, bottom temperature 39.9° F.

Except for its striate surface this species is very close to *L. elongata* (Ehrenberg).

LAGENA SULCATA (Walker and Jacob).

Plate 9, fig. 2.

"Serpula (Lagena) striata sulcata rotundata" WALKER and BOYS, Test. Min., 1784, p. 2, pl. 1, fig. 6.

Serpula (*Lagena*) *sulcata* WALKER and JACOB, Adams' Essays, Kanmacher's ed., 1798, p. 634, pl. 14, fig. 5.

Lagena sulcata PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 351.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 462, pl. 57, figs. 23, 26, 33, 34.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 307, pl. 53, fig. 7.—SIDEBOTTOM, Journ. Quekett Micr. Club, vol. 11, 1912, p. 389, pl. 15, figs. 24, 25.

Description.—Test flask-shaped, body portion subglobular, ornamented with numerous plate-like costæ running the length of the test, a few often more prominent than others, rather closely set and numerous, sometimes ending in spinose projections at the apical end; neck variously ornamented by costæ or annular rings.

Length 0.35 to 0.65 mm.

Distribution.—The only North Pacific stations from which I have had this species are all from Guam to Japan; off Guam, *Nero* station 1464 in 891 fathoms; between Guam and Yokohama, *Nero* stations 1065 in 1,321 fathoms and 1313 in 1,716 fathoms; and off Japan, *Albatross* station D4957 in 437 fathoms.

LAGENA SULCATA (Walker and Jacob), var. ALTICOSTATA, new variety.

Plate 9, fig. 5.

Description.—Test subglobular, ornamentation consisting of a few prominent primary costæ high, thin, and plate-like, running from the aperture to the apical end of the test; between these, secondary costæ running only to the base of the neck, the alternating ones of these being shorter; aperture small, rounded.

Length 0.4 mm.

Distribution.—Type-specimen, Cat. No. 8530, U.S.N.M., from *Nero* station 991 in 1,143 fathoms off Guam. It also occurred at *Nero* station 1466 in 234 fathoms in the same vicinity.

LAGENA SULCATA (Walker and Jacob), var. APICULATA, new variety.

Plate 9, figs. 3, 4.

Lagena sulcata, apiculate forms, H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 58, figs. 4, 17 (?).

Description.—Test like typical *L. sulcata*, but the apical end drawn out into a stout spine; aperture rounded.

Length 0.60–0.85 mm.

Distribution.—This variety occurred at *Nero* station 172 in 2,086 fathoms near the Midway Islands and at several *Nero* stations between Yokohama and Guam at depths ranging from 1,299 to 1,737 fathoms. It also occurred at two *Albatross* stations off Japan, D4807 in 44 fathoms and D5054 in 282 fathoms.

Type-specimen.—Cat. No. 8531, U.S.N.M., from *Nero* station 1440 in 1,737 fathoms.

LAGENA ACUTICOSTA Reuss.

Plate 8, figs. 9, 10; plate 23, fig. 2.

Lagena acuticosta Reuss, Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 305, pl. 1, fig. 4; vol. 46, pt. 1, 1862 (1863), p. 331, pl. 5, fig. 63.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 464, pl. 57, figs. 31, 32; pl. 58, figs. 20 (?), 21.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 222, pl. 44, figs. 26, 31.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 329, pl. 10, figs. 47, 48, 82, 83.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 388, pl. 15, fig. 22.

Description.—Test subglobular to pyriform, broadest toward the base and gradually tapering upward toward the apex; apertural end of the test smooth and unornamented, lower portion with comparatively few, thin, much elevated costæ running to the apical end of the test; aperture rounded.

Length 0.25 to 0.50 mm.

Distribution.—Brady mentions the occurrence of this species in the North Pacific. From the material I have been able to examine the species seems to be well distributed in the area, occurring at the following stations: *Albatross* H4857 in 324 fathoms in Bering Sea; H2922 in 268 fathoms off the Hawaiian Islands; *Nero* 991 in 1,143 fathoms off Guam; *Nero* 862 in 1,550 fathoms off Luzon; *Nero* 1160 in 1,907 fathoms between Guam and Yokohama; and two *Albatross* stations off Japan, H4878 in 84 fathoms and D4975 in 712 fathoms.

LAGENA ACUTICOSTA Reuss, var. PAUCICOSTATA, new variety.

Plate 9, fig. 1.

Lagena acuticosta Sidebottom (part), Journ. Quekett Micr. Club, vol. 11, 1912, p. 388, pl. 15, fig. 23 (not fig. 22).

Description.—Test more globular than in the typical, the costæ reduced to three, remaining portion of the test smooth; aperture very small, rounded.

Length 0.33 mm.

Distribution.—Type-specimen, Cat. No. 8532, U.S.N.M., from *Albatross* station D4887, in 71 fathoms off Japan.

This agrees well with the variety figured by Sidebottom as noted above, the three costæ forming the whole of the ornamentation of the test. In our specimen the costæ do not continue to the apertural end, though they do in the specimen figured by Sidebottom.

LAGENA GRACILIS Williamson.

Plate 8, figs. 5, 6.

Lagena gracilis Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 13, pl. 1, figs. 3, 4.—Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 2, 1862 (1863), p. 331, pl. 4, figs. 58–61; pl. 5, fig. 62.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 464, pl. 58, figs. 19, 22–24.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 328, pl. 10, figs. 25, 49.

Lagena vulgaris, var. *gracilis* Williamson, Rec. For. Great Britain, 1858, p. 7, pl. 1, figs. 12, 13.

Description.—Test elongate, fusiform, ornamented with 4 to 12 or more high costæ or plate-like ribs running the entire length of the test from near the aperture to the apical end, where they unite in an apical spine; neck slender, aperture small, rounded.

Length up to nearly 1 mm.

Distribution.—This species was found at numerous *Nero* stations between Yokohama and Guam, the depths ranging from 518 to 1,915 fathoms. It occurred off Guam, *Nero* station 1464 in 891 fathoms, and between Guam and Midway Islands, *Nero* station 542 in 1,996 fathoms. It also occurred at *Tuscarora* station 47, lat. 24° 21′ N.; long. 154° 06′ E., in 1,499 fathoms.

These North Pacific examples are very constant in their form and ornamentation, being of the form here figured. The number of costæ is somewhat variable.

LAGENA GRACILIS Williamson, var.

Plate 8, fig. 7.

Description.—Test elongate, the body of the test with numerous costæ, the apertural end with comparatively few, plate-like costæ independent of the costæ of the body.

Length 0.4 mm.

Distribution.—Figured specimen from *Nero* station 1294 in 1,417 fathoms between Guam and Yokohama.

LAGENA INFEROCOSTATA, new species.

Plate 8, fig. 8.

Description.—Test elongate, subcylindrical or fusiform, central portion with nearly parallel sides, abruptly pointed at either end; lower portion costate, the coarse costæ meeting in a ring at the base of the test; upper portion of test without costæ, nearly smooth except for a reticulation of irregularly placed depressions; aperture circular, without a definite neck.

Length 0.35 mm.

Distribution.—Type-specimen, Cat. No. 8533, U.S.N.M., from *Nero* station 1073 in 1,208 fathoms between Yokohama and Guam.

This species is remotely related to *L. acuticosta* in some of its characters.

LAGENA MUCRONULATA Reuss.

Plate 8, fig. 4.

Lagena mucronulata Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 329, pl. 4, fig. 52.

Description.—Test fusiform, the apical end tapering into a short spinose projection; the apertural end with a short neck, ending in a subglobular portion, the neck below being somewhat annular, surface ornamented with a few coarse costæ extending from a rim below the neck to the apical end.

Length 0.5 mm.

Distribution.—This species was found at *Nero* station 1064 between Guam and Yokohama in 1,588 fathoms.

The peculiar form of the test and the shape of the apertural end of the neck seem to be distinctive features.

LAGENA PLUMIGERA H. B. Brady.

Plate 12, fig. 4.

Lagena plumigera H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 62; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 465, pl. 58, figs. 25, 27.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 329, pl. 10, figs. 37, 38.—Millett, Journ. Roy. Micr. Soc., 1901, p. 490, pl. 8, fig. 8.

Description.—Test flask-shaped, broadest near the base tapering to a long slender neck; wall ornamented with seven to twelve longitudinal costæ, plate-like at the aboral end of the test spreading into wing-like expansions showing transverse striations.

Length 0.60 to 0.75 mm.

Distribution.—This species does not seem to have been previously reported from the North Pacific. Typical specimens were obtained in material from two *Nero* stations; 1117 in 2,123 fathoms and 1294 in 1,417 fathoms, between Yokohama and Guam.

Nearly all the records for the distribution of this species are in deep water and these two are no exceptions to the rule. Most of the stations are in tropical or subtropical waters but the depth at which the species has occurred precludes any influence of temperature in the distribution.

LAGENA STELLIGERA H. B. Brady.

Plate 12, fig. 3.

Lagena stelligera H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 60; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 466, pl. 57, figs. 35, 36.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 391, pl. 15, figs. 28, 29; pl. 16, figs. 1–4.

Description.—Test pyriform, broadest near the middle, tapering toward the truncate base and toward the obtusely pointed apertural end; aboral end of the test with a central raised circular rim from the periphery of which radiate eight to twelve short acute costæ extending a short distance up the basal portion of the test; wall smooth above or with slight crenulations about the aperture; the wall about the neck often with darker concentric circles of a slightly darker color.

Length 0.5 to 0.8 mm.

Distribution.—This species is recorded by Brady in the *Challenger* Report from deep water in the North Pacific Ocean in 2,300 fathoms. I have had specimens from three *Nero* stations between Yokohama and Guam, 1128 in 1,418 fathoms; 1294 in 1,417 fathoms, and 1318 in 1,210 fathoms.

In the work above quoted Sidebottom refers many variations to this species but in the material I have seen from these stations the specimens correspond very closely with the figures given by Brady, as will be seen from the specimen figured here.

LAGENA CRESCENTICOSTATA, new species.

Plate 17, figs. 1, 2.

Description.—Test ovate, widest below the middle, aboral end subtruncate, much compressed, surface with a broad flange-like extension ornamented with interrupted costæ, central portion of the test separated from the flange by a raised crescentiform ridge open at the aboral end, the central area ornamented by interrupted costæ, aperture with a short tapering neck.

Length 0.75 to 1.00 mm.

Distribution.—Type-specimens, Cat. No. 8534, U.S.N.M., from *Tuscarora* station 23, lat. 21° 40′ N.; long. 179° 20′ E., in 1,964 fathoms.

The ornamentation of this species is a peculiar one composed of the prominent oval ring and the irregular broken costæ of the rest of the test.

LAGENA STRIATO-AREOLATA Rymer-Jones.

Plate 14, figs. 5, 6.

Lagena vulgaris Williamson, var. *striato-areolata* Rymer-Jones, Trans. Linn. Soc., London, vol. 30, 1872, p. 53, pl. 19, figs. 21, 21*a*.

Lagena striato-areolata Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 390, pl. 15, fig. 27.

Description.—Test flask-shaped, neck long and slender, upper portion of test with four costæ becoming tubular or punctate below, intermediate portion composed of an irregular, generally hexagonal, net-work.

Length 0.5 mm.

Distribution.—The single specimen, which compares very favorably with the figure given by Sidebottom noted above, is from *Nero* station 172 in 2,086 fathoms, between the Hawaiian and Midway Islands.

LAGENA TORQUATA H. B. Brady.

Plate 11, fig. 3.

Lagena torquata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 62; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 469, pl. 58, fig. 41.

Description.—Test flask-shaped, neck long and slender, surface of test with a series of prominent primary longitudinal costæ with punctæ or tubulations down the middle of each, between each pair of primary costæ secondary costæ, imperforate, shorter and less prominent, and transversely finer ribs, breaking the whole up into a reticulate pattern.

Length 0.50 to 0.75 mm.

Distribution.—The only station at which this form occurred in the North Pacific material is *Nero* station 1122 in 1,926 fathoms, between Yokohama and Guam.

This species is close to *L. desmophora* and represents a higher development of the surface ornamentation in the transverse ribs and consequent reticulation of the surface.

LAGENA DESMOPHORA Rymer-Jones.

Plate 12, fig. 5; plate 13, fig. 3.

Lagena vulgaris Williamson, var. *desmophora* Rymer-Jones, Trans. Linn. Soc. London, vol. 30, 1872, p. 54, pl. 19, figs. 23, 24.

Lagena desmophora H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 468, pl. 58, figs. 42, 43.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 394.

Description.—Test flask-shaped, neck long and slender, surface ornamented with several longitudinal, primary costæ with tubulations, between which are usually secondary costæ, solid and nontubulated, aboral end with or without a spine or series of spines at the ends of the primary costæ.

Length 0.60 to 0.85 mm.

Distribution.—Brady records this species from a single North Pacific *Challenger* station in 1,850 fathoms. I have had specimens from several *Nero* stations; one between the Hawaiian and Midway Islands, 165 in 2,135 fathoms and the following stations in the lines of soundings between Guam and Yokohama; 1063 in 1,884 fathoms; 1145 in 2,119 fathoms; 1158 in 1,584 fathoms; 1301 in 1,088 fathoms; 1312 in 1,552 fathoms and 1323 in 1,583 fathoms.

The more simple of the specimens here figured may be perhaps closely related to *L. striato-punctata* in that it lacks the secondary costæ, but those costæ which are present are decidedly catenulate in character and I have included it here.

LAGENA EXSCULPTA H. B. Brady.

Plate 13, fig. 5.

Lagenulina sulcata Terquem (not *Lagena sulcata* (Walker and Jacob)), Essai Animaux plage Dunkerque, pt. 2, 1876, p. 68, pl. 7, fig. 9.

Lagena exsculpta H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 61; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 467, pl. 58, fig. 1; pl. 61, fig. 5.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 392.

Description.—Test subglobular or pyriform, rounded or compressed, apertural half of test smooth and unornamented, aboral half ornamented with numerous costæ, not raised above the surface of the remaining portion of the test, but made by the sculpturing of the intermediate areas.

Length 0.5 to 1.2 mm.

Distribution.—Brady records this from a single *Challenger* station in the North Pacific in 2,300 fathoms. I have had material from four *Nero* stations between Guam and Yokohama as follows: 1294 in 1,417 fathoms; 1295 in 1,415 fathoms; 1305 in 1,289 fathoms; and 1315 in 1,494 fathoms. All the *Challenger* records are in comparatively deep water.

All the North Pacific material which I have examined is of the compressed form figured by Brady.[1] Sidebottom notes that his South Pacific material is also of this same compressed form.

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[1] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 61, fig. 5.

LAGENA INTERMEDIA Sidebottom.

Plate 13, fig. 4.

Lagena semistriata? H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 465, pl. 57, fig. 20.

Lagena intermedia SIDEBOTTOM, Journ. Quekett Micr. Soc., vol. 11, 1912, p. 399, pl. 17, figs. 1–3.

Description.—Test pyriform, broadest near the base, circular in cross section; surface smooth, except the basal portion, which has an irregular series of costæ radiating from the center of the base; aperture fissurine.

Length 0.5 mm.

Distribution.—This species has occurred at but a single station, *Nero* 1163 in 2,049 fathoms between Guam and Yokohama.

This agrees very closely with some of the figures given by Sidebottom and with the figure in the *Challenger* Report, but the specimen here figured has also a secondary apical radiating group of costæ below the rim. In this regard this specimen is almost intermediate between the rounded specimens of *L. exsculpta* and *L. intermedia.* However, in its general characters this seems decidedly to belong to *L. intermedia.*

LAGENA FEILDENIANA H. B. Brady.

Plate 15, figs. 1, 2.

Lagena feildeniana H. B. BRADY, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 434, pl. 20, fig. 4; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 469, pl. 58, figs. 38, 39.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 328, pl. 10, fig. 100.

Description.—Test elongate, ovate, broad and rounded at the aboral end, tapering nearly to a point at the apertural end; surface ornamentation made up of numerous acute raised costæ running longitudinally the entire length of the test, the surface between consisting of longitudinal furrows each with a series of perforations, each in a slight depression and ovate in shape, the narrow end toward the apertural end of the test.

Length about 1 mm.

Distribution.—Brady records this species in the North Pacific from a single *Challenger* station in 2,300 fathoms. I have had it from a single *Albatross* station, D5085, in Sagami Bay, Hondo, Japan, in 622 fathoms, bottom temperature 37.8° F.

With a high-power lens to bring out the details of the ornamentation this is one of the most beautiful species of *Lagena.* The ornamentation is simple, but the delicacy of the sculpturing is really beautiful. This seems to be described by Sidebottom.[1] as *Lagena hertwigiana* H. B. Brady, var. *undulata* Sidebottom.

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[1] Journ. Quekett Micr. Club, vol. 11, 1912, p. 397, pl. 16, figs. 26–28.

LAGENA STRIATO-PUNCTATA Parker and Jones.

Plate 14, fig. 10.

Lagena sulcata, var. *striato-punctata* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 350, pl. 13, figs. 25–27.

Entosolenia striato-punctata G. M. Dawson, Can. Nat., vol. 5, 1870, p. 178, woodcut, p. 180, fig. 11.

Lagena striato-punctata H. B. Brady, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 434, pl. 20, fig. 3; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 468, pl. 58, figs. 37, 40.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 339, pl. 14, fig. 20.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 327, pl. 10, figs. 35, 36, 44–46.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 83, pl. 13, fig. 753.—Millett, Journ. Roy. Micr. Soc., 1901, p. 489, pl. 8, fig. 6.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 17, pl. 2, fig. 5; Journ. Quekett Micr. Club, vol. 11, 1912, p. 392, pl. 16, figs. 7–10.

Description.—"Test oval pyriform, or flask-shaped, and either ecto- or entosolenian. It is decorated externally with tolerably stout longitudinal costæ, from 6 to 20 in number, bearing conspicuous pseudopodial foramina. The perforations are placed either in single rows down the middle of the costæ, or in double lines, one on each side, in their thickened bases."

Length 0.3 mm.

Distribution.—Brady records this species from *Challenger* station 241 in 2,300 fathoms.

LAGENA FIMBRIATA H. B. Brady.

Plate 14, fig. 8.

Lagena fimbriata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 61; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 486, pl. 60, figs. 26–28.

Lagena orbignyana (?) Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 418, pl. 21, fig. 15.

Description.—"Test pyriform or flask-shaped, broad at the base, compressed; ento- or ecto-solenian; furnished with a deep vertical wing, encircling the oval base; the wing traversed by parallel tubuli, and sometimes fringed at the free margin."

Length 0.42 mm.

Distribution.—Among other stations Brady records this species from a *Challenger* station in the North Pacific in 2,300 fathoms.

The figure quoted above from Sidebottom's work on the Lagenæ of the Southwest Pacific seems possibly to be this same species, or at least closely related to it.

LAGENA STAPHYLLEARIA (Schwager).

Plate 17, fig. 3.

Fissurina staphyllearia SCHWAGER, *Novara*-Exped., Geol. Theil, vol. 2, 1866, p. 209, pl. 5, fig. 24.

Lagena staphyllearia H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 474, pl. 59, figs. 8–11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 331, pl. 10, figs. 50, 51, 99.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 307, pl. 54, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1901, p. 619, pl. 14, fig. 2.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 8, pl. 1, figs. 18–20; Journ. Quekett Micr. Soc., vol. 11, 1912, p. 403, pl. 17, figs. 19–24.

Lagena vulgaris, var. *spinicosto-marginata* RYMER-JONES, Trans. Linn. Soc. London, vol. 30, 1872, p. 57, pl. 19, figs. 34–36.

Description.—Test ovate, compressed, wall smooth, periphery keeled usually, with several spines symmetrically arranged about the border; aperture fissurine.

Length about 0.5 mm.

Distribution.—Apparently this species has not previously been recorded from the North Pacific. It has occurred at three *Nero* stations; 91 in 1,983 fathoms and 170 in 1,990 fathoms between the Hawaiian and Midway Islands and 862 in 1,550 fathoms off Luzon, Philippine Islands.

Both three- and five-spined specimens occur, but the range of variation shown by Sidebottom does not seem to exist in our specimens. The figured specimen is very similar to the one figured by Sidebottom as *Lagena fasciata* Egger, var. *spinosa* Sidebottom,[1] but our specimen lacks the ornamentation of *L. fasciata*. Otherwise the two are very similar.

LAGENA TRUNCATA H. B. Brady.

Plate 19, fig. 3.

Lagena truncata H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 457, pl. 56, figs. 31, 32.

Description.—Test elongate, pyriform; greatest breadth below the middle, aboral end broadly rounded; apertural end obtusely rounded; wall smooth; aboral end with two or more short spines; aperture radiate.

Length 0.4 to 1.0 mm.

Distribution.—This species occurred in material from *Nero* station 1065 in 1,321 fathoms between Guam and Yokohama.

Brady speaks of the aperture as "either round or fissurine" but the specimen figured has a decidedly radiate aperture. The optical section gives the form and comparative length of the entosolenian tube.

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[1] Journ. Quekett Micr. Club, vol. 11, 1912, p. 402, pl. 17, fig. 17.

LAGENA UNGUICULATA H. B. Brady.

Plate 11, fig. 1.

Lagena unguiculata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 61; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 474, pl. 59, fig. 12.

Description.—"Test pyriform, compressed; inferior end broad and tapering to a thin edge, which is furnished with a number of more or less curved teeth symmetrically set."

Length 0.35 mm.

Distribution.—On page 876 of the volume on the "Summary of Results of the Challenger Report," this species is recorded from station 224 in 1,850 fathoms.

This seems to be the only North Pacific record.

LAGENA AURICULATA H. B. Brady, var. COSTATA H. B. Brady.

Plate 14, fig. 2.

Lagena auriculata H. B. Brady, var. *costata* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 61; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 487, pl. 60, fig. 38.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 422, pl. 20, figs. 21, 22.

Description.—Variety with the body of the test costate and also carinate.

Length 0.25 mm.

Distribution.—Brady records this species from a single *Challenger* station in the North Pacific in 2,300 fathoms.

The figure is from the *Challenger* Report

LAGENA AURICULATA H. B. Brady, var. SUBCARINATA, new variety.

Plate 17, fig. 4.

Lagena auriculata H. B. Brady, var., Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 421, pl. 20, figs. 15–18.

Description.—Test ovate, somewhat compressed, central portion somewhat irregularly roughened, basal portion or whole test with a wide peripheral keel with two tubular projections from the lower border; entosolenian tube long and sinuous.

Length about 0.25 mm.

Distribution.—This variety occurred at *Nero* station 1300 between Guam and Yokohama, type-specimen, Cat. No. 8535, U.S.N.M., and at *Albatross* station D4957 in 437 fathoms off Japan.

This is the variety noted without name by Sidebottom. It seems worthy of some distinctive name that its distribution may be noted.

LAGENA AURICULATA H. B. Brady, var. LINEARITUBA, new variety.

Plate 17, fig. 5.

Lagena auriculata H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 487, pl. 60, fig. 31.

Description.—Test elongate, ovate, broadest below the middle, apical end broadly rounded, apertural end gradually tapering to an obtuse point; surface smooth, lateral tubulations much elongated and very shallow; aperture radiate.

Length 0.5 mm.

Distribution.—Type-specimen, Cat. No. 8536, U.S.N.M., from *Nero* station 1294 between Guam and Yokohama in 1,417 fathoms

This is the form referred by Brady to this species with a question.

LAGENA ALVEOLATA H. B. Brady.

Plate 18, fig. 1.

Lagena alveolata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 487, pl. 60, figs. 30, 32.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 15, pl. 2, fig. 17; Journ. Quekett Micr. Club, vol. 11, 1912, p. 424, pl. 21, figs. 1, 2.

Description.—"Test pyriform compressed, lateral edges obtuse or rounded; base broad and round in outline, rarely mucronate; furnished with a median and two lateral carinae, which unite so as to form two loops on each side of the test, usually separated by a central depression."

Length 0.3 to 0.5 mm.

Distribution.—Brady records this species from a single station in the North Pacific in 2,300 fathoms. I have had the typical form from three *Nero* stations between Guam and Yokohama; 1065 in 1,321 fathoms, 1155 in 1,632 fathoms and 1440 in 1,737 fathoms.

The species seems to occur nearly always in deep water as noted by Brady. This typical form of the species is small, the test subtransparent, the loops entirely at the sides, very different from the following.

LAGENA ALVEOLATA H. B. Brady, var. PLEBEIA, new variety.

Plate 18, fig. 2.

Description.—Test larger than the typical, coarser, opaque, walls thick, the three keels separated from one another, forming two gaping depressions at either side of the median keel, margins roughened, apertural end much like the typical.

Length 0.5 to 0.9 mm.

Distribution.—This form is by far the most common of the species in the North Pacific. It occurred at *Nero* station 170 in 1,990 fathoms, southeast of the Midway Islands, and at 10 stations between Guam and Yokohama, in depths varying from 1,040 to 2,250 fathoms.

Type-specimen.—Cat. No. 8537, U.S.N.M., from *Nero* station 1160 in 1,907 fathoms. It also occurred at *Tuscarora* station 2 in lat. 21° 07′ N.; long. 158° 14′ W. in 1,468 fathoms.

LAGENA ALVEOLATA H. B. Brady, var. SUBSTRIATA H. B. Brady.

Plate 18, fig. 5.

Lagena auriculata H. B. BRADY, var. *substriata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 61.

Lagena alveolata H. B. BRADY, var. *substriata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 488, pl. 60, fig. 34.—SIDEBOTTOM, Journ. Quekett Micr. Soc., vol. 11, 1912, p. 424.

Description.—Variety characterized by the body portion of the test being striate or costate, especially about the base and somewhat less so toward the apertural end.

Length 0.60 mm.

Distribution.—I have had specimens of this variety from *Tuscarora* station 5, lat. 37° 04′ N.; long. 123° 22′ W., in 1,200 fathoms and from four *Nero* stations between Guam and Yokohama as follows: 1299 in 1,817 fathoms, 1301 in 1,088 fathoms, 1320 in 2,048 fathoms, and 1324 in 1,915 fathoms.

The basal costæ in this variety seem not to extend up beyond the lower half of the test.

LAGENA ALVEOLATA H. B. Brady, var. BASIEXCAVATA, new variety.

Plate 18, fig. 4.

Description.—Variety characterized by two costæ on each side in the middle of the inferior half of the test, each forking near the periphery and the two angles thus formed excavated.

Length 0.75 mm.

Distribution.—Type-specimen Cat. No. 8538, U.S.N.M., from *Nero* station 1185 in 1,491 fathoms between Yokohama and Guam.

The peculiar costæ and basal excavations will distinguish this variety.

LAGENA ALVEOLATA H. B. Brady, var. PROLONGATA, new variety.

Plate 18, fig. 3.

Description.—Variety differing from the others by having a much elongated neck instead of the typical bluntly pointed test.

Length 0.65 mm.

Distribution.—Type-specimen Cat. No. 8539, U.S.N.M., from *Nero* station 1299 in 1,817 fathoms between Yokohama and Guam.

All other forms which I have seen have the aperture without a definite neck, but in this variety the test is gradually prolonged into a long tapering neck.

LAGENA QUADRATA (Williamson).

Plate 14, fig. 9.

Entosolenia marginata, var. *quadrata* Williamson, Rec. Foram. Great Britain, 1858, p. 11, pl. 1, figs. 27, 28.

Lagena lucida, var. *quadrata* Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 324, pl. 2, fig. 26.

Lagena quadrata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 475, pl. 59, figs. 3, 16.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 331, pl. 10, figs. 78, 79.—Millett, Journ. Roy. Micr. Soc., 1901, p. 496, pl. 8, fig. 18.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 8, pl. 1, figs. 21, 22; pl. 2, figs. 1–3.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 142.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 18, pl. 2, fig. 8 [?]; Journ. Quekett Micr. Club, vol. 11, 1912, p. 405, pl. 17, figs. 26–28 [?].

Description.—Test compressed, somewhat quadrate in outline, usually somewhat keeled, aperture somewhat elongate, wall smooth.

Length 0.5 mm.

Distribution.—Bagg records this species from *Albatross* stations H4440 in 1,259 fathoms and H4694 in 865 fathoms off the Hawaiian Islands. I have had the typical form only from *Nero* station 1208 in 665 fathoms between Guam and Yokohama.

LAGENA QUADRATA (Williamson), var. RIZZÆ (Seguenza).

Plate 19, fig. 4.

Fissurina rizzæ Seguenza, Foram. monotal. Mioc. Messina, 1862, p. 72, pl. 2, fig. 50.

Lagena quadrata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 475, pl. 60, fig. 5.

Description.—Test subquadrate, compressed, central portion smooth, each side with a peripheral carina just back from the edge of the test, neck short, aperture with a broad phialine lip.

Length 0.5 mm.

Distribution.—This variety occurred at two *Nero* stations 1464 in 891 fathoms near Guam and 1310 in 518 fathoms between Guam and Japan.

This is close to the form figured by Brady in the *Challenger* report and seems near enough to the above form described by Seguenza to warrant the use of his name for it.

LAGENA QUADRICOSTULATA Reuss.

Plate 14, fig. 1.

Lagena quadricostulata Reuss, Sitz. Akad. Wiss. Wien, vol. 62, 1870, p. 469.—Schlicht, Foram. Pietzpuhl, 1870, pl. 4, figs. 25–30.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 486, pl. 59, figs. 7(?), 15.

Description.—"Test pyriform and more or less compressed, the margin obtuse or rounded, the base frequently mucronate, and the aperture entosolenian; the surface bears four arched costæ, two on each face of the test, near the lateral margins and parallel to them.

The costæ are thickest near the middle, and taper away toward the ends."

Length 0.25 mm.

Distribution.—In the volumes on the "Summary of Results of the *Challenger* Expedition" this species is recorded on page 965 from station 246 in 2,050 fathoms, and on page 937 recorded with a question from station 237. In many respects this is close to *L. fasciata* Egger.

LAGENA LUCIDA (Williamson).

Entosolenia marginata, var. *lucida* Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 17, pl. 2, fig. 17.

Lagena lucida Reuss, Sitz. Akad. Wiss. Wien, vol. 46, 1862 (1863), p. 324, pl. 2, figs. 25, 26.—Balkwill and Millett, Journ. Micr., vol. 3, 1884, p. 80, pl. 2, fig. 7; pl. 3, figs. 4, 5.—Millett, Journ. Roy. Micr. Soc., 1901, p. 494.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 6, pl. 1, figs. 9–12; vol. 54, No. 16, 1910, p. 17, pl. 2, fig. 7; Journ. Quekett Micr. Club, vol. 11, 1912, p. 401, pl. 17, figs. 12–14.

Description.—Test somewhat compressed, marginal portion and central area clear and translucent, with a rather broad more or less opaque band between, wall smooth, aperture usually fissurine or rounded.

Length 0.3 to 0.8 mm.

Distribution.—At three North Pacific stations excellent specimens of this species were found, *Nero* station 1464 in 891 fathoms off Guam; 1129 in 1,505 fathoms southeast of Japan; and *Albatross* H4881 in 316 fathoms off Japan.

The specimens vary much in outline, one being very truncate and broad at the apertural end, others rounded.

LAGENA FASCIATA Egger, var. SPINOSA Sidebottom.

Lagena fasciata Egger, var. *spinosa* Sidebottom, Journ. Quekett Micr. Soc., vol. 11, 1912, p. 402, pl. 17, figs. 16, 17.

Description.—Test ovate, compressed, central portion ornamented by two bands on each side nearly meeting at the apertural and aboral ends; periphery with an apical and two lateral spines; aperture fissurine, made up of a linear series of small openings.

Length 0.5 mm.

Distribution.—Sidebottom described this variety from the South Pacific. The only station in the North Pacific from which I have material is *Albatross* D4972 in 440 fathoms, bottom temperature 39.8° F. off Japan.

This is similar to the specimen figured here as *L. staphyllearia*, but that lacks the characteristic ornamentation of *L. fasciata*.

LAGENA FASCIATA Egger, var. CARINATA Sidebottom.

Plate 21, fig. 1.

Lagena fasciata Egger, var. *carinata* Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 7, pl. 1, fig. 17; Journ. Quekett Micr. Club, vol. 11, 1912, p. 403, pl. 17, fig. 18.

Description.—Test more or less compressed, each side of the body portion with a curved band, usually hollowed somewhat into the surface of the test, the periphery of the test with a keel, surface otherwise smooth.

Length 0.35 to 0.85 mm.

Distribution.—This variety occurred at several *Nero* stations in the vicinity of the Hawaiian Islands at depths ranging from 22 to 2,098 fathoms; between Guam and Yokohama at several *Nero* stations ranging in depth from 1,417 to 1,817 fathoms; at two *Albatross* stations off Japan, D4825, in 120 fathoms, and H4878, in 84 fathoms, and two *Tuscarora* stations; 28 in lat. 35° 15′ N.; long. 120° 58′ W., in 65 fathoms, and 47 in lat. 24° 20′ N.; long. 154° 06′ E., in 1,499 fathoms.

LAGENA SEMINIFORMIS Schwager.

Plate 11, fig. 2.

Lagena seminiformis Schwager, *Novara* Exped., Geol. Theil., vol. 2, 1866, p. 208, pl. 5, fig. 21.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 478, pl. 59, figs. 28–30.

Lagena marginata, var. *seminiformis* Millett, Journ. Roy. Micr. Soc., 1901, p. 620, pl. 14, fig. 3.

Description.—Test circular or ovate in front view, with a comparatively long tubular neck, whole surrounded by a wide, thin peripheral keel, extended at each side of the base into long pointed projections; wall smooth.

Length up to 1.26 mm.

Distribution.—Brady records this species from a single North Pacific station, *Challenger*, 224 in 1,850 fathoms.

LAGENA MARGINATA (Walker and Boys).

Plate 22, figs. 1–7.

Serpula (*Lagena*) *marginata* Walker and Boys, Test. Min., 1784, p. 2, pl. 1, fig. 7.

Vermiculum marginatum Montagu, Test. Brit., 1803, p. 524.

Entosolenia marginata Williamson (part), Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 17, pl. 2, figs. 15–17.

Lagena marginata Brown, Illus. Conch. Great Britain, 1827, pl. 1, figs. 30, 31.—Reuss, Sitz. Acad. Wiss. Wien, vol. 46, 1862 (1863), p. 322, pl. 2, figs. 22*a*, *b*, 23*a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 476, pl. 59, figs. 21–23.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 222, pl. 44, figs. 27, 29, 30, 32.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 332, pl. 10, figs. 20, 66, 67, 96, 97.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 81, pl. 13, fig. 748; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 52.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 307, pl. 54, fig. 2.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 141.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 405, pl. 17, figs. 29–31; pl. 18, figs. 1–3.

Description.—Test more or less compressed, rounded in front view, wall smooth, bordered by a peripheral keel of greater or less width, solid or with radiating tubuli, aperture usually fissurine.

Length 0.25 to 1.50 mm.

Distribution.—This species in its various modifications is common in the North Pacific. Goës records it from the eastern Pacific in 695 to 1,201 fathoms and Bagg from four *Albatross* stations in the vicinity of the Hawaiian Islands, D4017, D4174, H4430, and H4696, in 305, 735–865, 1,544, and 367 fathoms, respectively. I have seen specimens from *Nero* station 172 in 2,086 fathoms near the Midway Islands, *Albatross* H3007 in 323 fathoms near the Hawaiian Islands, from over 25 *Nero* stations between Guam and Yokohama at depths ranging from 518 to 2,250 fathoms, from three *Albatross* stations off Japan, D4843, D4875, and D4953, in 100, 59, and 1,350 fathoms, respectively. It also occurred at two *Tuscarora* stations, 47 in lat. 24° 20′ N.; long. 154° 06′ E., in 1,499 fathoms, and 58 in lat. 26° 52′ N.; long. 142° 21′ E., in 814 fathoms.

There is much variation in the comparative breadth and the character of the keel and in the amount of compression of the test and in the size of various specimens.

LAGENA MARGINATA (Walker and Boys), var.

Plate 21, fig. 2.

Description.—Test with a thin peripheral keel, broadest toward the base and sides, slightly emarginate below and gradually decreasing in width toward the apertural end, where it ceases entirely, leaving the upper third of the test noncarinate.

Length 0.75 mm.

Distribution.—Found at three stations between Guam and Yokohama, *Nero* stations 1155 in 1,632 fathoms, 1299 in 1,817 fathoms, and 1300 in 1,529 fathoms.

This is somewhat different from typical *L. marginata.*

LAGENA MARGINATA (Walker and Boys), var.

Plate 21, fig. 3.

Description.—Test compressed, with a peripheral keel similar to the preceding, but inside it a band similar to *L. fasciata* next an opaque band and a clear center, as in *L. lucida.*

Length 0.85 mm.

Distribution.—Found at *Albatross* station H2766 off the Hawaiian Islands in 196 fathoms.

This is a rather peculiar form, uniting, as it does, the characters of *L. marginata, L. fasciata,* and *L. lucida.*

LAGENA LAGENOIDES (Williamson).

Plate 16, fig. 2.

Entosolenia marginata WALKER and BOYS, var. *lagenoides* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 11, pl. 1, figs. 25, 26.

Lagena lagenoides REUSS, Sitz. Akad. Wiss. Wien, vol. 46, 1862, p. 324, pl. 2, figs. 27, 28.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 479, pl. 60, figs. 6, 8, 9, 12.—MILLETT, Journ. Roy. Micr. Soc., 1901, p. 623, pl. 14, fig. 8.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 141.—SIDEBOTTOM, Journ. Quekett Micr. Club, vol. 11, 1912, p. 411, pl. 18, figs. 22–28.

Description.—Test flask-shaped, usually compressed, body oval or ovate, surrounded by a simple peripheral keel which has numerous radiating tubulations, neck usually comparatively short, in complete specimens usually joined with the peripheral keel.

Length 0.4 to 1 mm.

Distribution.—The single *Albatross* station, H4566, in 572 fathoms off the Hawaiian Islands, seems to be the only record for this species in the North Pacific. I have a single specimen, here figured, from *Nero* station 1310 in 518 fathoms, between Yokohama and Guam.

There are apparently various modifications of the tubulated keeled Lagenas and from the North Pacific material at least two which may be definitely distinguished. Therefore I have here restricted the use of the name to those specimens which have a peripheral keel, which in its unbroken condition extends entirely about the periphery of the test, is rather remotely tubulated, the neck usually seeming a portion of the keel, comparatively short, usually the keel not emarginate but entire.

LAGENA LAGENOIDES (Williamson), var. TENUISTRIATA H. B. Brady.

Plate 16, fig. 3.

Lagena tubulifera H. B. BRADY, var. *tenuistriata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 61.

Lagena lagenoides WILLIAMSON, var. *tenuistriata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 479, pl. 60, fig. 11 (not 15, 16).—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 12, pl. 2, figs. 9, 10; Journ. Quekett Micr. Club, vol. 11, 1912, p. 413, pl. 19, figs. 4, 5.

Description.—Test flask-shaped, pyriform, keel with comparatively few, large, remote tubulations; body of test not greatly compressed; surface ornamented with coarse longitudinal costæ running the length of the body of the test.

Length 0.35 to 0.50 mm.

Distribution.—This restricted varietal form has occurred at four stations in the *Nero* material at one station; 542 in 1,996 fathoms between Midway Islands and Guam and three stations; 1137 in 2,250 fathoms; 1160 in 1,907 fathoms, and 1287 in 1,606 fathoms between Guam and Yokohama.

In the *Challenger* report under this variety Brady figures what seem from a study of the North Pacific material to be two distinct forms. In plate 60, figure 11, is given a figure of a specimen which in its essential characters is very similar to the specimen figured here, plate 16, figure 3. On plate 60, figures 15, 16 are figured specimens with a very wide keel with numerous fine tubulations and the surface ornamented with very fine striations instead of costæ. I find in the North Pacific material that this distinction is met with in all the specimens examined, and I have included under Brady's var. *tenuistriata* such specimens as are figured here and selected by Sidebottom in his figures above referred to. The other form is placed under the following species.

LAGENA SUBLAGENOIDES, new species.

Plate 16, fig. 4.

Lagena lagenoides (part) H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 479, pl. 60, figs. 13, 14.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 44, fig. 23.—Millett, Journ. Roy. Micr. Soc., 1901, p. 623, pl. 14, fig. 9 [?]

Description.—Test flask-shaped, much compressed, central body of test elongate ovate tapering into a long, slender neck, surrounded by a wide peripheral keel with numerous close-set, fine tubulations, central portion smooth, apical end of keel usually but not always emarginate.

Length 0.60 to 0.85 mm.

Distribution.—This, like *L. formosa* Schwager, seems to be a deep-water species. It was found at three North Pacific stations; *Albatross* D2806 in 1,379 fathoms off the Galapagos Islands; *Nero* 170 in 1,990 fathoms and 173 in 2,111 fathoms near the Midway Islands. Type-specimen, Cat. No. 8540, U.S.N.M. from *Albatross* station D2806.

This seems to be a distinct species from the ordinary forms of *L. lagenoides* Williamson, distinguishable by its much broader keel, with numerous fine, closely set tubulations, and long, slender neck.

LAGENA SUBLAGENOIDES, new species, var. STRIATULA, new variety.

Plate 16, fig. 5.

Lagena lagenoides (Williamson), var. *tenuistriata* H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 479, pl. 60, figs. 15, 16 (not fig. 11).

Description.—Variety distinguished from the typical form by the surface ornamentation of the body of the test, consisting of delicate, slightly irregular longitudinal striæ.

Length 1 mm.

Distribution.—Strangely enough this variety was not found at any of the stations where the typical form occurred. Type-specimen, Cat. No. 8541, U.S.N.M., from *Nero* station 1440 in 1,737 fathoms, north of Guam. It also occurred at three other *Nero* stations; 1439 in 1,901 fathoms also north of Guam; 1691 in 1,912 fathoms between Guam and the Midway Islands, and 166 in 1,850 fathoms between the Midway and Hawaiian Islands.

This variety is characterized by very fine, often slightly wavy longitudinal striæ, a type of ornamentation which seems to go with the broad keel with fine tubulations.

LAGENA FORMOSA Schwager.

Plate 11, fig. 6.

Lagena formosa Schwager (part), *Novara* Exped., Geol. Theil, vol. 2, 1886, p. 207, pl. 4, figs. 19*a*, 19*d* (not 19*b*, 19*c*).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 480, pl. 60, figs. 10, 18–20.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 53.—Millett, Journ. Roy. Micr. Soc., 1901, p. 624, pl. 14, figs. 10–12.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 414, pl. 19, figs. 6–9.

Lagena lagenoides Egger (not Williamson), Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 335, pl. 10, fig. 85.

Description.—Test flask-shaped, compressed, body of test elongate oval, with a long, tapering, slender neck, the central portion of the test immediately surrounded on either side by a raised edge outside of which peripherally is a broad keel with radiating fine tubulations; apertural and apical ends of the central portion of the test passing into the inner keel by a series of interrupted costæ, apical end of peripheral keel usually emarginate.

Length up to 1 mm. or more.

Distribution.—Brady records this species from two *Challenger* stations in the North Pacific, in 1,850 and 2,575 fathoms. Goës records it from *Albatross* station 3399 in the eastern Pacific in 1,740 fathoms. I have found this species to be fairly common in the *Nero* material from the region between Guam and Yokohama, mostly in comparatively deep water, the depths varying from 1,417 to 2,119 fathoms. It occurred near Guam at *Nero* station 1464 in 891 fathoms; near the Midway Islands, *Nero* station 170 in 1,990 fathoms; station 91 in 1,983 fathoms and off the Hawaiian Islands, *Nero* station 10 in 2,098 fathoms.

This is a large and beautifully ornamented species. It seems to be widely distributed in deep water.

LAGENA FORMOSA Schwager, var. FAVOSA H. B. Brady.

Plate 11, fig. 7.

Lagena formosa Schwager, var. *favosa* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 480, pl. 60, fig. 21.

Description.—Variety differing from the typical in having two or three rows of reticulate ornamentation between the body of the test and the peripheral wing.

Length 1 mm.

Distribution.—Described by Brady in the *Challenger* report from *Challenger* station 224 in 1,850 fathoms in the western part of the North Pacific.

LAGENA FORMOSA Schwager, var. COMATA H. B. Brady.

Plate 11, fig. 8.

Lagena formosa SCHWAGER, var. *comata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 480, pl. 60, fig. 22.

Description.—Variety differing from the typical in having the body of the test striate and the periphery and base of the neck reticulate.

Length 0.85 mm.

Distribution.—This variety was described by Brady from *Challenger* station 224 in 1,850 fathoms in the western part of the North Pacific. The only North Pacific station from which I have seen this variety is *Nero* 1464 in 891 fathoms.

LAGENA BICARINATA Terquem, var. LATEROCOSTATA, new variety.

Description.—Test compressed, ovate in front view, periphery of test concave with a keel at either side, on each side of the body portion posteriorly a short, curved, prominent costa, remainder of body surface smooth.

Length 0.4 mm.

Distribution.—Type-specimen Cat. No. 8553, U.S.N.M., from *Nero* station 1012 in 1,932 fathoms north of Guam.

LAGENA ORBIGNYANA (Seguenza).

Plate 19, fig. 1.

Entosolenia marginata WILLIAMSON (part) (not *L. marginata* (Walker and Boys)), Rec. For. Great Britain, 1858, p. 9, pl. 1, figs. 19, 20.

Fissurina orbignyana SEGUENZA, Foram. monotal. Mioc. Messina, 1862, p. 66, pl. 2, figs. 24, 26.

Lagena orbignyana H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 484, pl. 59, figs. 1, 18, 24, 26.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 222, pl. 44, fig. 20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 333, pl. 10, figs. 89–91.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 308, pl. 54, fig. 4.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 50, No. 5, 1906, p. 12, pl. 2, fig. 11.

Lagena orbignyana, var. *elongata* GOËS, Bull. Mus. Comp. Zool., vol. 29, 1896, p. 52.

Description.—Test rounded or elongate, ovate, much compressed, whole test surrounded by a peripheral keel inside of which on either side of the test is a complete raised rim about the body proper, neck somewhat elongate, wall smooth, in side view appearing tricarinate.

Length 0.5 to 0.7 mm.

Distribution.—Goës records the elongate form of this species from *Albatross* stations in the eastern Pacific in 1,132 to 1,201 fathoms. I have had specimens from *Nero* station 2049 in 2,226 fathoms off the Hawaiian Islands and from numerous stations between Guam and Yokohama, depths ranging from 688 to 1,907 fathoms. It also occurred at two *Albatross* stations off Japan, D4957 in 437 fathoms and D4975 in 712 fathoms.

The elongate form here figured has occurred much more frequently than the rounded form.

LAGENA ORBIGNYANA (Seguenza), var. LACUNATA (Burrows and Holland).

Plate 20, fig. 1.

Lagena castrensis H. B. Brady (not Schwager), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 485, pl. 60, figs. 1, 2.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 341, pl. 12, figs. 20, 21.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 333, pl. 10, figs. 71, 72.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 308, pl. 54, fig. 5.

Lagena lacunata Burrows and Holland, in Jones, Palaeont. Soc., 1895, p. 205, pl. 7, fig. 12.

Lagena orbignyana, var. *castrensis* Millett, Journ. Roy. Micr. Soc., 1901, p. 626, pl. 14, fig. 20.

Lagena orbignyana, var. *lacunata* Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 19, pl. 2, fig. 14; Journ. Quekett Micr. Club, vol. 11, 1912, p. 416, pl. 19, figs. 16–18.

Description.—Variety with the body portion of the test marked by a network of lacunæ or pitted areas of varying size, usually darker in color than the rest of the test.

Length 0.35 mm.

Distribution.—Brady records this variety from the *Challenger* station south of Japan on the *Hyalonema*-ground, depth 345 fathoms. I have had material from three *Nero* stations between Guam and Yokohama, 1154 in 1,602 fathoms, 1300 in 1,529 fathoms, and 1310 in 518 fathoms. It also occurred at two *Albatross* stations off Japan, D4875 in 59 fathoms and D4966 in 290 fathoms, and at *Tuscarora* station 23, lat. 21° 40′ N.; long. 179° 20′ E., in 1,964 fathoms.

Schwager's figure and description call for a specimen with its ornamentation made up of raised beads on the body portion of the test. It seems that a distinction should be made between the raised beads and pitlike lacunæ.

LAGENA ORBIGNYANA (Seguenza), var. CORONATA Sidebottom.

Plate 20, fig. 3.

Lagena orbignyana (Seguenza), var. *coronata* Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 416, pl. 19, fig. 15.

Description.—Variety with the central area translucent, surrounded by an opaque band, outside of which is the inner keel, peripherally bordered by the wider median keel, which is denticulate about the basal half of the border.

Length of North Pacific specimens 1 mm.

Distribution.—Found in the North Pacific material only at *Albatross* station H2902 in 1,783 fathoms near the Hawaiian Islands.

This seems to agree nearly enough with the above variety to warrant its being placed here. The opaque ring is here decidedly raised and annular but the other characters are very similar.

LAGENA ORBIGNYANA (Seguenza), var. CONCENTRICA Sidebottom.

Plate 19, fig. 2.

Lagena orbignyana (Seguenza), var. *concentrica* Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 417, pl. 19, fig. 23.

Description.—Test compressed, but umbonate, median keel well developed, inner keel less prominent; body portion ornamented by concentric costæ, apertural end bluntly pointed.

Length 0.6 mm.

Distribution.—Figured specimen from *Nero* station 1464 in 891 fathoms off Guam.

Although more umbonate than shown in the figure referred to above, this specimen has all the essential characters of this variety.

LAGENA ORBIGNYANA (Seguenza), var. CLATHRATA H. B. Brady.

Plate 11, fig. 4.

Lagena clathrata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 484, pl. 60, fig. 4.—Balkwill and Millett, Journ. Micr., vol. 3, 1884, p. 82, pl. 2, fig. 14; pl. 4, fig. 3.

Lagena orbignyana, var. *clathrata* Millett, Journ. Roy. Micr. Soc., 1901, p. 628, pl. 14, fig. 23.—Sidebottom, Journ. Quekett Micr. Club, vol. 11, 1912, p. 418.

Description.—Variety with the central portion of the test ornamented with longitudinal costæ.

Length 0.25 mm.

Distribution.—This variety occurred at two *Nero* stations, 1294 in 1,417 fathoms and 1448 in 2,084 fathoms between Guam and Yokohama.

Our specimens are not typical of the variety, as they are much more finely costate than is Brady's figure of this variety.

LAGENA ORBIGNYANA (Seguenza), var. CRENULATA, new variety.

Plate 20, fig. 2.

Description.—Variety with the central portion of the test ornamented by very slightly developed, irregular striæ, the border regularly pitted, inner keel normal, outer keel broad, the surface between the two keels regularly crenulated, apertural end with a short broad neck, truncate.

Length 0.35 mm.

Distribution.—Type-specimen, Cat. No. 8542, U.S.N.M., from *Albatross* station H4878 in 84 fathoms off Japan. It also occurred at *Albatross* station D4957 in 437 fathoms; also off Japan and *Nero* station 1464 in 891 fathoms off Guam.

This variety seems rather distinctive.

LAGENA ORBIGNYANA (Seguenza), var. ALATA, new variety.

Plate 23, fig. 1.

Description.—Variety with the central portion smooth, except at the border, where it is regularly pitted, peripheral keel extended outward into a very broad, thin keel extending about the entire test from the aperture, radiately striate, basal border tending to become denticulate.

Length 0.45 mm.

Distribution.—Type-specimen, Cat. No. 8543, U.S.N.M., from *Albatross* station D4953 in 1,350 fathoms off Japan.

This seems to be different from any of the previously described varieties of this species.

LAGENA FAVOSO-PUNCTATA H. B. Brady.

Plate 11, fig. 5.

Lagena favoso-punctata H. B. Brady, Quart. Journ. Micr. Soc., vol. 21, 1881, p. 62; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 473, pl. 58, fig. 35; pl. 59, fig. 4; pl. 61, fig. 2.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 325, pl. 10, fig. 98.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 140.

Description.—Test ecto- or entosolenian, shape variable; surface areolated or reticulated, with a conspicuous orifice or perforation in the middle of each area or depression.

Length 0.34 mm. or less.

Distribution.—The only North Pacific records for this species are those given by Bagg, H4590 in 978 fathoms and H4694 in 865 fathoms off the Hawaiian Islands.

LAGENA TRIGONO-MARGINATA Parker and Jones

Plate 14, figs. 3, 4.

Lagena trigono-marginata Parker and Jones, Philos. Trans., vol. 155, 1865, p. 348, pl. 18, figs. 1*a*, *b*.—Wright, Proc. Belfast Nat. Field Club, 1876–77, App., p. 104, pl. 4, figs. 8*a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 482, pl. 61, figs. 12, 13.

Description.—Test ovate or pyriform, trifacial, the angles of the test ornamented by a marginal beading with an acute edge often subcarinate, or smooth and without the beading, occasionally rounded and not distinctly carinate, aperture rounded.

Length 0.35 mm.

Distribution.—Brady records this species from one North Pacific *Challenger* station, 241 in 2,300 fathoms.

This has by some authors been referred to *L. orbignyana* as a variety.

Subfamily 2. NODOSARIINÆ.

Test polythalamous; chambers arranged in a straight, arcuate, planospiral or uncoiling series, apertures either radiate or with a neck and phialine lip.

Genus NODOSARIA Lamarck, 1812.

Nodosaria Lamarck (type, *N. raphanistrum* (Linnæus), (Extrait Cours Zool., 1812, p. 121; Hist. Anim. Sans Vert., vol. 7, 1822, p. 596.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 488.

Description.—Test composed of a straight or arcuate series of chambers, either loosely joined together by stolons or close-set and overlapping or various forms between; surface smooth or ornamented; aperture either radiate or with a definite neck and phialine lip.

In this genus both microspheric and megalospheric forms occur. In some species the megalospheric proloculum is the largest chamber of the series and none of the following chambers attain so large a diameter. In the microspheric form the proloculum is very small and the chambers gradually increase in size.

Some species tend to show definite senescent characters in the loss of the ornamentation in the later developed chambers. In some cases also the last formed chamber tends to become separated from the preceding ones by a constriction of the connection between them and a *Lagena*-like last chamber results.

In some species the ornamentation extends back to the proloculum which assumes the characteristic costæ, etc., of adult chambers.

In the subgenus *Glandulina* there is a tendency for the chambers to reach back and overlap the preceding ones, often making the sutures hardly visible, with little or no depression.

In *Dentalina* there is a tendency toward an arcuate form with the sutures coincidently oblique instead of directly transverse. Such conditions tend toward the theory that these may in reality be uncoiled forms which have in the megalospheric form at least lost their early coiled stages. The microspheric form in rare cases shows a tendency of the early chambers to be coiled in these arcuate and oblique sutured forms.

It is possible that *Glandiolus* Montfort, 1808, may have to replace *Nodosaria* Lamarck, 1812, if an examination of Montfort's types shows that the two are synonymous. At present Montfort's poorly executed figures make it impossible to determine his species with certainty without such an examination of types, and at present this is impossible.

NODOSARIA (GLANDULINA) ROTUNDATA (Reuss).

Plate 28, fig. 6.

Glandulina rotundata Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 366, pl. 46, fig. 2.

Nodosaria (*Glandulina*) *rotundata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 491, pl. 61, figs. 17–19.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 308, pl. 54, fig. 6.—Millett, Journ. Roy. Micr. Soc., 1902, p. 510.

Description.—Test oval or subovate, broadest in the middle, composed of few chambers, apical end broadly rounded, without spines, apertural end more elongate, aperture with radiate lines about the margin; last-formed chamber occupying one-half or more of the visible test.

Length 1 to 2 mm.

Distribution.—This species has not previously been recorded from the North Pacific. I have found it at *Albatross* station D4807, off Japan, in 44 fathoms.

Millett raises the question as to whether this and *N. laevigata* are microspheric and megalospheric forms of a single species.

In the figured specimen the last-formed chamber occupies rather more than usual of the surface of the test.

NODOSARIA (GLANDULINA) LAEVIGATA d'Orbigny.

Plate 24, figs. 1, 2.

"Cornu Hammonis erectum globosius" Plancus, Conch. Min., 1739, p. 16, pl. 13, fig. 1.

Nodosaria (*Glandulina*) *laevigata* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 252, pl. 10, figs. 1–3.—Parker and Jones, Philos. Trans., vol. 155, 1865, p. 340, pl. 13, fig. 1.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 490, pl. 61, figs. 20–22.—Burrows, Sherborn, and Bailey, Journ. Micr. Soc., 1890, p. 556, pl. 19, figs. 14, 15.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 71, pl. 13, figs. 702, 703, 705, 707, 709; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 59.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 308, pl. 55, fig. 3.—Millett, Journ. Roy. Micr. Soc., p. 509, pl. 11, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 143.

Glandulina laevigata d'Orbigny, For. Foss. Bass. Tert. Vienne, 1846, p. 29, pl. 1, figs. 4, 5.—Bornemann, Zeitschr. deutsch. Geol. Gess., vol. 7, 1855, p. 320, pl. 12, fig. 8.—Neugeboren, Denkschr. Akad. Wiss. Wien, vol. 12, 1856, p. 67, pl. 1, figs. 3, 4.—Haeusler, Neues Jahrb. für Min., 1887, p. 189, pl. 5, fig. 29.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 336, 339, pl. 11, fig. 31.—Silvestri, Mem. Pont. Accad. Nuovi Lincei, vol. 17, 1900, p. 248, pl. 6, figs. 41, 49.

Description.—Test fusiform, very broad in the middle, tapering rapidly toward either end; apical end usually with one or more spines;

chambers few, embracing, the last-formed one making up two-thirds or more of the visible test, sutures flush but marked by a distinct fine line; apical end somewhat rounded, usually with radiate lines about the aperture; wall smooth.

Length 2 mm. or more.

Distribution.—Brady records this species from the North Pacific in 7–95 fathoms. The latter depth represents the *Challenger* station off the Philippines. Goës records it at four *Albatross* stations in the eastern Pacific, D3371 in 770 fathoms, D3375 in 1,201 fathoms, D3376 in 1,132 fathoms, and D3407 in 885 fathoms. Bagg records it from three stations off the Hawaiian Islands, *Albatross* D4025 in 275–368 fathoms, H4555 in 1,398 fathoms, and H4696 in 367 fathoms. I have had material from the western portion of the region, *Albatross* D4843, off the coast of Korea in 100 fathoms, bottom temperature 39.9° F.

NODOSARIA CALOMORPHA Reuss.

Plate 25, fig. 6.

Nodosaria calomorpha Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 129, pl. 1, figs. 15–19.—Terrigi, Atti Accad. Pont., ann. 33, 1880, p. 178, pl. 1, fig. 7.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 497, pl. 61, figs. 23–27.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 44, figs. 1, 4?—Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 566, pl. 9, fig. 21.—Terrigi, Mem. Com. Geol. Italia, vol. 4, 1891, p. 78, pl. 2, fig. 5.—Chaster, First Rep. Southport Soc. Nat. Sci., 1890–1891 (1892), p. 63, pl. 1, fig. 12.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 340, pl. 11, figs. 21, 26.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 72, pl. 13, figs. 712, 713.—Morton, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 118, pl. 1, fig. 6.—Millett, Journ. Roy. Micr. Soc., 1902, p. 513.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 1, pl. 1, figs. 1–8.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 142.

Description.—Test elongate, usually somewhat arcuate, composed of a few elliptical chambers in adult specimens three to five in number; wall smooth or occasionally with a few very delicate hispid spines, wall transparent; both ends broadly rounded, smooth; aperture a simple opening without neck.

Length 0.50–1.00 mm.

Distribution.—Brady records this species in the North Pacific at a single *Challenger* station off the Philippines in 95 fathoms. Bagg records it at a single *Albatross* station, H4508, in 495 fathoms off the Hawaiian Islands. I have a single specimen here figured, plate 25, figure 6, from *Nero* station 1313, in 1,716 fathoms, between Guam and Japan.

This seems in all its characters to be a primitive species and one with little character except the form, the few chambers, and the transparent wall of the test. These elementary characters, however, seem to be rather constant.

NODOSARIA SIMPLEX Silvestri.

Plate 28, fig. 5.

Nodosaria simplex Silvestri, Atti Accad. Gioenia, Catania, ser. 3, vol. 7, 1872, p. 95, pl. 11, figs. 268–272.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 496, pl. 62, figs. 4, 5, and 6?—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 340, pl. 11, fig. 6.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 309, pl. 55, fig. 2.

Description.—Test composed of two or more chambers, the initial chamber globular with a short spine at the base, the second pyriform with a well drawn out neck and radiate aperture; wall smooth, sutures well depressed.

Length about 1 mm.

Distribution.—There are no previously published records for this species in the North Pacific. The only record I have is *Albatross* D2806 off the Galapagos Islands in 1,379 fathoms. The specimen obtained here is very typical, like Silvestri's figures and like fig. 4 of the *Challenger* report.

NODOSARIA PYRULA d'Orbigny.

Plate 26, figs. 1–3.

"Orthoceras Monile" Soldani, Testaceographia, vol. 2, 1798, p. 35, pl. 10, figs. *b*, *c*.

Nodosaria pyrula d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 253, No. 13.—Williamson, Rec. Foram. Great Britain, 1858, p. 17, pl. 2, fig. 39.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 497, pl. 62, figs, 10–12.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1885, p. 343, pl. 12, fig. 23.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 44, fig. 2.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 345, pl. 11, figs. 14, 15.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 309, pl. 55, fig. 4.—Millett, Journ. Roy. Micr. Soc., 1902, p. 514.

Description.—Test elongate, very slender, composed of numerous chambers, either in a straight or slightly curved line, pyriform in shape with long tapering necks; surface smooth, chambers varying little in size; proloculum extended backward in a long drawn out point.

Length up to 8 mm.

Distribution.—Brady records this species at two *Challenger* stations, 95 fathoms off the Philippines and the *Hyalonema*-grounds off Japan, 345 fathoms. Goës had specimens which he records under *N. monile* from two *Albatross* stations, D3375 in 1,201 fathoms and D3431 in 995 fathoms, in the eastern Pacific. I have seen only broken specimens in the material examined from *Albatross* station D4891, off Japan, 181 fathoms, bottom temperature 50.2° F., and D4807, off Japan, in 44 fathoms.

Specimens are rarely obtained in an entire condition due to the delicacy of the connecting stolonlike necks. It is a species of comparatively shallow and comparatively warm water from the records available.

NODOSARIA PYRULA d'Orbigny, var. SEMIRUGOSA d'Orbigny.

Plate 26, figs. 4–8.

Nodosaria semirugosa d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 34, pl. 1, figs. 20–23.—Millett, Journ. Roy. Micr. Soc., 1902, p. 515, pl. 11, fig. 5.

Nodosaria No. 35, von Schlicht, Foram. Septarien Thones von Pietzpuhl, 1870, p. 24, pl. 7, fig. 20.

Nodosaria stipitata Reuss, var. *costulata* Reuss, Sitz. Akad. Wiss. Wien, vol. 62, Abth. 1, 1870, p. 471.

Nodosaria costulata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 515, pl. 63, figs. 23–27.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 312, pl. 58, fig. 1.

Description.—Similar to typical *Nodosaria pyrula*, but with the basal portion of each chamber with several costæ and alternating depressions.

Distribution.—Brady records this species at the *Challenger* station off the Philippines in 95 fathoms. I have it from *Albatross* D4807 in 44 fathoms off Japan. From material examined it seems that this is but a variable form of *N. pyrula* and frequently occurs with it in tropical and subtropical waters. Millett is certainly right in referring this form to *N. semirugosa* d'Orbigny.

NODOSARIA GUTTIFERA (d'Orbigny).

Plate 35, fig. 5.

Dentalina guttifera d'Orbigny, For. Foss. Bass. Tert. Vienne, 1846, p. 49, pl. 2, figs. 11–13.—H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 296, pl. 12, fig. 2.

Nodosaria guttifera Steinmann, Elem. Palæont., vol. 1, 1888, p. 27, fig. 8. B.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 143.

Description.—Test composed of a few chambers, each pyriform in shape connected by stolonlike tubes, broadly rounded at base, thence tapering gradually to the apertural end, wall smooth.

Length 2.5 mm.

Distribution.—Bagg refers to this species fragments of *Nodosaria* found at *Albatross* station H4566 in 572 fathoms off the Hawaiian Islands. One of these is here figured.

Of d'Orbigny's figures in the Vienna Basin Monograph, figure 11 seems certainly to be referable to *N. pyrula* d'Orbigny, but figure 13 is much more like the specimens found by Bagg. It is not like the ordinary form or size of *N. pyrula*.

NODOSARIA PAUPERATA (d'Orbigny).

Plate 25, fig. 7.

Dentalina pauperata d'ORBIGNY, For. Foss. Bass. Tert. Vienne, 1846, p. 46, pl. 1, figs. 57, 58.—BORNEMANN, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 324, pl. 13, fig. 7.—H. B. BRADY, Proc. Somerset Arch. and Nat. Hist. Soc., vol. 13, 1867, p. 108, pl. 1, fig. 14.

Nodosaria pauperata H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 500, woodcuts figs. 14*a*, *b*, *c*.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 68, pl. 12, figs. 682–688 [part]; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 61.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 144.

Description.—Test comparatively short, slightly arched, tapering, composed of a few chambers, cylindrical in the early portion, later chambers more inflated; apical end usually with a short spine; apertural end slightly prolonged.

Length 2 mm.

Distribution.—Goës records rather poor examples of this species from three *Albatross* stations in the eastern Pacific, D3363 in 978 fathoms, D3376 in 1,132 fathoms, and D3399 in 1,740 fathoms. Bagg records it from the vicinity of the Hawaiian Islands at two *Albatross* stations, D4000 in 104–213 fathoms and D4025 in 275–368 fathoms. These specimens also are not typical, one broken one being here figured. It is not mucronate and the apertural portion is broken away.

NODOSARIA ABYSSORUM H. B. Brady.

Plate 28, fig. 7.

Nodosaria (?) *abyssorum* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 63; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 504, pl. 63, figs. 8, 9.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 342, pl. 11, fig. 11 [?].

Description.—Test elongate, composed of several chambers, straight or slightly arcuate, chambers inflated, subspherical, sutures much depressed, surface smooth, apical end broadly rounded, with a group of short acicular spines; aperture at the end of a short neck, with a phialine lip.

Length up to 4 mm.

Distribution.—This species has not previously been recorded in the North Pacific. I have it from two stations, *Nero* 1302 in 1,331 fathoms and 1867 in 2,311 fathoms in the western Pacific. The figured specimen from the first station is evidently broken, showing but the two early chambers. The specimen from the second station is also broken, but composed of eight chambers, and except for the larger number of chambers and broken lip is very similar to Brady's figures in the *Challenger* report.

This seems to be a rare, deep-water species.

NODOSARIA PROXIMA Silvestri.

Nodosaria proxima Silvestri, Atti Accad. Gioenia, Catania, ser. 3, vol. 7, 1872, p. 63, pl. 6, figs. 138–147.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 511, pl. 64, fig. 15.—Fornasini, Mem. Accad. Sci. Bologna, ser. 5, vol. 4, 1894, p. 206, pl. 1, figs. 33–35.—Millet, Journ. Roy. Micr. Sci., 1902, p. 519, pl. 11, fig. 9.

Description.—Test composed of few chambers, usually two, with several costæ, apical end often spinose; aperture at the end of a tubular neck.

Length 1 mm.

Distribution.—Brady records this species from two North Pacific stations, off the Philippines in 95 fathoms and from the coral reefs of Honolulu, Sandwich Islands, in 40 fathoms. I have seen no material which can not be referred to other species as young specimens.

NODOSARIA RADICULA (Linnæus).

"Cornu Hammonis erectum" Plancus, Conch. Min., 1739, p. 14, pl. 1, fig. 5.

Nautilus radicula Linnæus, Syst. Nat., ed. 12, 1767, p. 1164, 285; (Gmelin's) ed. 13, 1788, vol. 1, pt. 6, p. 3373, No. 18.—Montagu, Test. Brit., 1803, p. 197, pl. 6, fig. 4.

Nodosaria radicula d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 252, No. 3; Modèles, No. 1.—H. B. Brady, Proc. Somerset Arch. and Nat. Hist. Soc., vol. 13, 1867, p. 106, pl. 1, fig. 4; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 495, pl. 61, figs. 28–31.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 746, pl. 14, fig. 24.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 60.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 309, pl. 55, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1902, p. 513.

Description.—Test elongate, composed of three or four chambers, with but slightly depressed sutures, wall smooth, apical end with a short spine; aperture at the end of a slightly produced neck.

Length about 2 mm.

Distribution.—Goës records this species from one *Albatross* station in the eastern Pacific, D3375 in 1,201 fathoms. I have had specimens from *Albatross* station H2999 in 549 fathoms, off the Hawaiian Islands, and from two *Nero* stations 1463 in 951 fathoms and 990 in 859 fathoms, both off Guam.

NODOSARIA INFLEXA Reuss.

Plate 25, fig. 1.

Nodosaria inflexa Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1866, p. 131, pl. 2, fig. 1; Sitz. Akad. Wiss. Wien, vol. 62, 1870, p. 472, No. 16.—von Schlicht, For. Septarien Thones von Pietzpuhl, 1870, pl. 38, fig. 3.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 498, pl. 62, fig. 9.

Description.—Test elongate, tapering, slightly arcuate, chambers comparatively few, pyriform, united to one another with slight necks; wall smooth, portion of each chamber near the distal end clear, giving a darker appearance to that portion of the chamber.

Length 2 mm. or more.

Distribution.—Brady records this species at the *Challenger* station off the Philippines in 95 fathoms. I have had material from three stations, *Tuscarora* 2, lat. 21° 07′ N., long. 158° 14′ W., in 1,468 fathoms, and *Albatross* D4843 in 100 fathoms and D4979 in 943 fathoms. The bottom temperatures at these two stations were 39.9° and 36.4° F., respectively.

In some ways this species is intermediate between *N. pyrula* and *N. soluta*, and may be only a variety of the former. The peculiar dark appearance of the clear portions is rather distinctive.

NODOSARIA SOLUTA (Reuss).

Plate 26, figs. 9–11.

Dentalina soluta Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 60, pl. 3, figs. 4*a*, *b*.—Stache, *Novara* Exped., Geol. Theil, vol. 1, 1864, p. 203, pl. 22, fig. 29.—Hantken, Mitth. Jahrb. Ung. Geol. Anstalt., vol. 4, 1875, p. 29, pl. 2, figs. 2, 14.

Nodosaria soluta Bornemann, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 322, pl. 12, fig. 12.—Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 131, pl. 2, figs. 4–8.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 503, pl. 62, figs. 13–16; pl. 64, fig. 28.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 746, pl. 14, figs. 25, 26.—Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 557, pl. 9, fig. 26.—Chapman, Journ. Roy. Micr. Soc., 1893, p. 587, pl. 8, fig. 26.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 70, pl. 12, fig. 690; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 62.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 310, pl. 56, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1902, p. 516.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 144.

Description.—Test elongate, somewhat arcuate, comparatively stout, composed of rather few globular or ovate chambers, inflated, sutures much depressed, aperture radiate with an acute neck, apical end often with a short spine; wall of the distal portion of the chamber smooth, the proximal half of each chamber usually roughened, often conspicuously so, sometimes faintly striate; color chalky white, opaque.

Length up to 6 mm. or more.

Distribution.—Goës recorded this species from the eastern Pacific at three *Albatross* stations, D3375, in 1,201 fathoms; D3376, in 1,132 fathoms; and D3407, in 885 fathoms. Flint records it from *Albatross* station, D2805, in 51 fathoms, Panama Bay, and Bagg from one *Albatross* station, H4964, in 865 fathoms, off the Hawaiian Islands. The only stations from which I have had material are, *Nero* 1298, in 1,711 fathoms, off Japan, and *Albatross* D4957, in 437 fathoms, also off Japan.

NODOSARIA HAUERIANA Neugeboren.

Plate 25, fig. 4.

Nodosaria haueriana NEUGEBOREN, Verh. Mitth. sieb. Ver. Nat., vol. 3, 1852, p. 39, pl. 1, figs. 8, 9.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 341, pl. 11, figs. 1, 25.

Description.—Test elongate, tapering, composed of few chambers, elongate pyriform, sutures much depressed, wall smooth, apertural end of last formed chamber very tapering.

Length about 1.50 mm.

Distribution.—Egger records this species off West Australia. The specimen here figured is from *Albatross* station D4966, off Japan, in 290 fathoms, bottom temperature 44.1° F.

NODOSARIA COMMUNIS d'Orbigny.

Plate 28, figs. 1, 2.

Nodosaria (Dentalina) communis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 254, No. 35.

Dentalina communis D'ORBIGNY, Mém. Soc. Géol. France, vol. 4, 1840, p. 13, pl. 1, fig. 4.

Nodosaria communis REUSS, Verst. Böhm. Kreid., pt. 1, 1845, p. 28, pl. 12, fig. 21.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 504, pl. 62, figs. 19–22.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 557, pl. 9, fig. 27.—CHAPMAN, Journ. Roy. Micr. Soc., 1893, p. 590, pl. 9, fig. 1.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 342, pl. 11, figs. 22–24.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 67, pl. 12, figs. 667–671; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 61, pl. 6, fig. 1.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 310, pl. 56, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1902, p. 522.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 142.

Description.—Test elongate, slender, tapering, straight or more often slightly curved, composed of numerous chambers, slightly inflated toward the apical end but later ones becoming more inflated; sutures oblique; aperture radiate somewhat eccentric, elongate somewhat; surface smooth.

Length up to 3 mm. or more.

Distribution.—Goës records this species at three stations in the eastern Pacific, *Albatross*, D3376, in 1,132 fathoms; D3400, in 1,322 fathoms; and H2627, in 1,839 fathoms. Bagg records it from the vicinity of the Hawaiian Islands, D4000, in 104–213 fathoms; D4025, in 275–368 fathoms; H4430, in 1,544 fathoms; and H4566, in 572 fathoms. I have had material from numerous stations well scattered over the region between San Francisco and Hawaii, near Guam, several stations between Guam and Yokohama, and several stations off the coast of Japan. The shallowest depth is 124 fathoms and the deepest 2,615 fathoms.

Many very different forms have often been included in this species, and it may be questioned whether Brady was really correct in placing our recent material with d'Orbigny's Cretacean species.

NODOSARIA FILIFORMIS d'Orbigny.

Plate 27, figs. 1–4.

"Orthoceratia filiformia aut capillaria" SOLDANI, Testaceographia, vol. 2, 1798, p. 35, pl. 10, fig. *e*.

Nodosaria filiformis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 253, No. 14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 500, pl. 63, figs. 3–5.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 310, pl. 55, fig. 6.—MILLETT, Journ. Roy. Micr. Soc., 1902, p. 523.

Dentalina filiformis PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 156, pl. 9, fig. 48.

Description.—Test elongate, slender, arcuate, chambers numerous, elliptical or ovate, elongate, tumid, sutures usually oblique, chambers increasing in length toward the apertural end, aperture radiate, slightly eccentric; wall smooth.

Length up to 5 mm.

Distribution.—Brady in the *Challenger* report mentions this species as being found in the North Pacific, but stations are not given. I have had material from the following stations: *Albatross* D3608 in 276 fathoms; material from stomachs of holothurians, D4900, in 139 fathoms off Japan; *Nero* station 1466, near Guam, in 234 fathoms; and *Tuscarora* station 11, in 437 fathoms, lat. 33° 46′ N.; long. 140° 21′ E.

Specimens are easily broken and complete specimens seem to be rare.

NODOSARIA ROEMERI (Neugeboren).

Plate 24, figs. 4–6.

Dentalina roemeri NEUGEBOREN, Denkschr. Akad. Wiss. Wien, vol. 12, 1856, p. 82, pl. 2, figs. 13–17.

Nodosaria roemeri REUSS, Sitz. Akad. Wiss. Wien, vol, 62, 1870, p. 475.—VON SCHLICHT, Foram. Septarien Thones von Pietzpuhl, 1870, pl. 10, figs. 21, 22, 24.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 505, pl. 63, fig. 1.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 310, pl. 56, fig. 5.

Description.—Test elongate, somewhat arcuate, comparatively stout, composed of few chambers, early ones with little inflation, later ones somewhat inflated, apical end rounded, sutures oblique, wall smooth.

Length up to 4.5 mm.

Distribution.—Bagg records this species from one *Albatross* station off the Hawaiian Islands, H4566, in 572 fathoms. I have had material from three *Nero* stations, 10, near the Hawaiian Islands, in 2,098 fathoms; 201, near Midway Islands, in 1,033 fathoms; and 990, near Guam, in 859 fathoms.

The species is not well distinguished from *N. communis* and seems to be intermediate between this and *N. mucronata*.

NODOSARIA CONSOBRINA (d'Orbigny), var. EMACIATA (Reuss).

Plate 27, fig. 9.

Dentalina emaciata Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 63, pl. 3, fig. 9.

Nodosaria (D.) consobrina, var. *emaciata* Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 132, pl. 2, figs. 12, 13.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 502, pl. 62, figs. 25, 26.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 310, pl. 56, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 143.

Description.—Test elongate, tapering, slightly curved, composed of numerous chambers, short and cylindrical in form, sutures but slightly depressed in the early portion, later chambers more tumid and sutures somewhat depressed; wall smooth, apical and rounded.

Length up to 8 mm.

Distribution.—Bagg records this form from *Albatross* station D4000 in 104–213 fathoms off the Hawaiian Islands. I have had material from the same region at *Albatross* station H2922 in 268 fathoms, bottom temperature, 44.8° F.; H2986 in 271 fathoms; and *Nero* station 2071 in 271 fathoms. It occurred at *Nero* station 1464 in 891 fathoms, off Guam; and *Albatross* stations H4882 in 248 fathoms, off southern Japan, bottom temperature, 48.8° F., and D4965, also off Japan, in 191 fathoms, bottom temperature, 49.4° F.

NODOSARIA MUCRONATA (Neugeboren).

Plate 24, fig. 3; plate 25, fig. 2; plate 27, figs. 5–7; plate 35, fig. 6.

"Orthoceras intortum" Soldani, Testaceographia, vol. 1, pt. 2, 1791, p. 98, pl. 105, fig. V.

Nodosaria (Dentalina) obliqua d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 254, No. 36; Modèles No. 5 (not *N. obliqua* (Linnæus)).

Dentalina mucronata Neugeboren, Denkschr. Akad. Wiss. Wien, vol. 12, 1856, p. 83, pl. 3, figs. 8–11.

Nodosaria mucronata Reuss, Sitz. Akad. Wiss. Wien, vol. 62, 1870, p. 475, No. 30.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 506, pl. 62, figs. 27–31.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 44, fig. 10.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 311, pl. 57, fig. 2.

Description.—Test elongate, tapering, broadest near the apertural end, composed of few chambers; wall smooth, sutures flush but distinct, oblique, apical end of test often with a spine; aperture with a short neck at the acute end of the chamber, radiate.

Length up to about 1.50 mm.

Distribution.—The only previous record for this species in the North Pacific is a *Challenger* station in 345 fathoms, *Hyalonema*-ground off Japan, given by Brady. I have material from off the Hawaiian Islands, *Nero* station 2071 in 271 fathoms; from off Japan, *Albatross* station D4954 in 957 fathoms; and at four *Nero* stations, 1145, 1293, 1299, and 1302, between Guam and Japan, with depths, respectively, 2,119, 2,141, 1,817 and 1,331 fathoms.

At *Nero* station 1145 a specimen was found, plate 35, figures 6*a*, *b*, which may be compared to some of the abnormal specimens, figured by Brady and others. Such forms seem to occur rather frequently in this species.

NODOSARIA JAPONICA, new species.

Plate 28, fig. 4.

Description.—Test much elongate, large, tapering, composed of numerous cylindrical chambers, sutures of clear material, walls of chambers whitish; apical end often slightly bulbous at the beginning then somewhat contracting before again enlarging as chambers are added; walls smooth, sutures indistinct in outline, but very distinct on account of the difference in texture of the material forming them; last formed chamber in adult specimens often more rounded and distinct, aperture with a tapering neck which is fluted about the opening.

Length up to 16 mm.

Distribution.—This species has occurred off Japan at *Albatross* station D4900 in 139 fathoms, bottom temperature 52.9° F. This seems to be a well-distinguished species.

Type-specimen.—Cat. No. 8544, U.S.N.M.

NODOSARIA CATENULATA H. B. Brady.

Plate 25, fig. 3.

Nodosaria catenulata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 515, pl. 63, figs. 32–34.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 312, pl. 58, fig. 2.

Description.—Test elongate, slender, straight or more often slightly arcuate, tapering; apical end bearing a well-developed spine; chambers numerous, elliptical or ovate, distinctly separated by deep sutures; walls smooth, ornamented by four or six equidistant longitudinal costæ bridging the depressions between the chambers but usually not continuous over the chambers; costæ more or less rounded; aperture small at the end of a long tapering neck, the apertural end of which is costate giving a stellate appearance in end view.

Length up to 2 mm.

Distribution.—Brady described this species from off the Philippine Islands in 95 fathoms. The only other North Pacific record I have for this species is *Albatross* station H2922 in 268 fathoms off the Hawaiian Islands. Brady records it also from Torres Strait and it is apparently a warm-water species.

The figured specimen is a young one consisting of but three chambers. The view by transmitted light shows the relation of the chambers and the wall.

NODOSARIA LONGIROSTRATA, new species.

Plate 27, fig. 8.

Description.—Test elongate, composed of few very elongate chambers, sutures slightly depressed, wall smooth, aperture at the end of a long tubular neck, somewhat clavate at the tip with several flange-like extensions, bicarinate.

Length of broken specimen 2.50 mm.

Distribution.—Type-specimen, Cat. No. 8545, U.S.N.M., from *Albatross* station D4949 in 110 fathoms, off Japan, bottom temperature 57.8° F.

This is a very elongate species, the chambers being several times as long as wide and the peculiar form of the apertural end makes it especially distinctive.

NODOSARIA SCALARIS (Batsch).

Plate 24, fig. 7.

"Orthoceratia Flosculi" SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, p. 91, pl. 95, figs. B–M.

Nautilus (*Orthoceras*) *scalaris* BATSCH, Conch. des Seesandes, 1791, No. 4, pl. 2, figs. 4*a*, *b*.

Nodosaria scalaris PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 340, pl. 16, figs. 2*a*, *b*, *c*.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 157, pl. 9, fig. 42.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 510, pl. 63, figs. 28–31.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 44, figs. 6, 19.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 73, pl. 13, figs. 716–718.

Nodosaria longicauda D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 254, No. 28.

Description.—Test composed of few nearly spherical chambers, rapidly increasing in size as added, apical end often with a spine, surface ornamented with numerous longitudinal raised costæ, aperture at the end of a fairly long neck ornamented with transverse ring-like costæ.

Length 1.50–3.00 mm.

Distribution.—From the material I have examined this species seems to be the most common in the region. Brady records it from two *Challenger* stations, off the Philippines, 95 fathoms, and off the south coast of Japan on the *Hyalonema*-ground, 345 fathoms. Bagg records it from *Albatross* station H4566 in 572 fathoms off the Hawaiian Islands. I have had material from a large number of stations, off the Hawaiian Islands, off Guam, and especially between Guam and Japan. The depth varies from 84 to 1,503 fathoms.

There is a considerable variation in the number and prominence of the costæ in different specimens and also in the various chambers of the same specimen as in plate 24, figure 7. The aperture is interesting, often being surrounded by several tooth-like prominences.

NODOSARIA RAPHANUS (Linnæus).

Plate 26, figs. 12, 13.

"Cornu Hammonis erectum striatum" PLANCUS, Conch. Min., 1739, p. 15, pl. 1, fig. 6.

"Orthoceras minimum" etc. GAULTIERI, Index Test., 1742, pl. 19, fig. L.

Nautilus raphanus LINNÆUS, Syst. Nat., ed. 12, 1767, p. 1164, (Gmelin's), ed. 13, 1788, p. 3372, No. 16.

Orthocera raphanus LAMARCK, Anim. sans. Vert., vol. 7, 1822, p. 593, No. 1; Tabl. Encycl. et Méth., pl. 465, fig. 2*a*, *b*, *c*.

Nodosaria raphanus PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 3, 1859, p. 477.—SILVESTRI, Atti Accad. Gioenia, Catania, ser. 3, vol. 7, 1872, p. 43, pl. 4, figs. 67–81.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 512, pl. 64, figs. 6–10.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 64.

Goës in the paper last quoted above records this species from *Albatross* station D3353 in 695 fathoms, one small specimen. I have been unable to find a specimen so labeled in the Goës collection, and as there are no other records for the species in this region the record must remain a doubtful one.

NODOSARIA OBLIQUA (Linnæus).

Plate 25, fig. 5.

"Orthoceras minimum" etc. GAULTIERI, Index Test., 1742, pl. 19, fig. N.

Nautilus obliquus LINNÆUS, Syst. Nat., ed. 12, 1767, p. 1163 (Gmelin's), ed. 13, 1788, p. 3372, No. 14.

Nodosaria (*Dentalina*) *obliqua* PARKER and JONES, Ann. Mag. Hist., ser. 3, vol. 3, 1859, p. 482.

Nodosaria obliqua H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 513, pl. 64, figs. 20–22.—H. B. BRADY, PARKER, and JONES, Trans. Zoöl. Soc. London, vol. 12, 1888, p. 223, pl. 44, fig. 7.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 63.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 311, pl. 57, fig. 4.

Description.—Test long and tapering, composed of numerous chambers, slightly inflated toward the apical end, more inflated and distinctly separated toward the apertural end, apical end usually with a single large spine, surface of the test with numerous distinct costæ running longitudinally the length of the test, aperture with an elongate neck smooth or nearly so.

Length up to 8–10 mm. or even more.

Distribution.—Brady speaks of this species as found in "every sea and at almost every depth from the laminarian zone to 1,500 to 2,000 fathoms." Goës found specimens from two stations off the west coast of North America, *Albatross* D3376 in 1,132 fathoms and D3407 in 885 fathoms. I have seen a few broken specimens only in the region.

NODOSARIA VERTEBRALIS (Batsch).

Plate 32, fig. 1.

Nautilus (*Orthoceras*) *vertebralis* BATSCH, Conch. des Seesandes, 1791, p. 3, No. 6, pl. 2, fig. 6*a*, *b*.

Nodosaria vertebralis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 514, pl. 63, fig. 35; pl. 64, figs. 11–14.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 312, pl. 57, fig. 5.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 312, pl. 57, fig. 5.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 144.

Description.—Elongate, slender, tapering, straight or very slightly arcuate, chambers comparatively short, numerous, little inflated, sutures of clear shell material, appearing darker than the opaque portions; surface ornamented with longitudinal costæ, apical end usually with a short spine.

Length up to 6 mm.

Distribution.—The only record from the North Pacific is that of Bagg, *Albatross* station D4000 in 104–213 fathoms off the Hawaiian Islands. From its distribution this seems to be a species of comparatively warm shallow water of tropical and subtropical seas.

NODOSARIA HIRSUTA d'Orbigny.

Plate 28, fig. 3.

"Orthoceratia quasi hispida" SOLDANI, Testaceographia, vol. 2, 1798, p. 15, pl. 2, fig. P.

"Orthoceratia hispida" SOLDANI, Testaceographia, vol. 2, 1798, p. 36, pl. 11, figs. *n–z*, A, B.

Nodosaria hirsuta D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 252, No. 7.

Nodosaria hispida D'ORBIGNY, For. Foss. Bass. Tert. Vienne, 1846, p. 35, pl. 1, figs. 24, 25.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, p. 154, pl. 9, fig. 45.—SILVESTRI, Atti Accad. Gioenia, Catania, ser. 3, vol. 7, 1872, p. 80, pl. 9, figs. 207–228.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 507, pl. 63, figs. 12–16.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 343, pl. 12, fig. 31.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 748, pl. 14, fig. 32.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 44, figs. 3, 5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 343, pl. 11, fig. 16.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 311, pl. 57, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1902, p. 515.

Description.—Test tapering, elongate, composed of few chambers, globular, surface covered with spines of varying coarseness, chambers close set or separated by stolonlike connections, aperture at the end of a tubular neck.

Length up to 2.5 mm.

Distribution.—Brady records this species from a *Challenger* station off the Philippines in 95 fathoms. The only specimen I have referable to this species is from D4900 off Japan in 139 fathoms, bottom temperature 52.9° F. This specimen which is figured here is somewhat broken and is not typical.

Genus LINGULINA d'Orbigny, 1826.

Lingulina d'Orbigny (type *L. carinata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 256.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 517.

Description.—Test compressed, chambers arranged in a linear series, usually closely set; aperture usually elongate, corresponding to the form of the chamber.

This genus seems to be less clearly defined than many of the genera established by d'Orbigny. It is closely related to *Nodosaria*, differing from this genus only in the compressed character and the consequent changes in the aperture.

Species of this genus are few in number but have a wide range. It is most common as a fossil in the Miocene.

LINGULINA CARINATA d'Orbigny.

Plate 29, fig. 3.

Lingulina carinata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 257, No. 1; Modèles No. 26.—Barker, Webb, and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, Foraminifères, 1839, p. 124, pl. 1, figs. 5, 6.—Williamson, Rec. Foram. Great Britain, 1858, p. 14, pl. 2, figs. 33–35.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 517, pl. 65, figs. 16, 17.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1888, p. 343.—Sherborn and Bailey, Journ. Roy. Micr. Soc., 1890, p. 558, pl. 10, fig. 3.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 484.—Egger, Abh. kön. bay. Acad. Wiss. München, Cl. ii, vol. 18, 1893, p. 345, pl. 11, fig. 8, 20.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 312, pl. 58, fig. 3.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 144.

Nodosaria carinata Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 74, pl. 13, figs. 714–715 [?].

Description.—Test compressed, chambers in a linear series, early ones short and broad, later ones usually hyaline, edges nearly acute, surface smooth; aperture an elongated, simple ellipse without a definite neck or radiate openings.

Length up to 3 mm.

Distribution.—In the North Pacific, Brady records this species from the *Challenger* dredgings, off the Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. Bagg records it as rare off the same islands, *Albatross* station 4508, in 495 fathoms. This is the specimen figured here.

Many forms have been figured as belonging to this species which it does not seem should be placed here, as their characters are so unlike the type of d'Orbigny's species.

Genus TRIPLASIA Reuss, 1854.

Vaginulina D'ORBIGNY (part), Ann. Sci. Nat., vol. 7, 1826, p. 258.
Orthocerina D'ORBIGNY (part) in De la Sagra, Hist. Fis. Pol. Nat., Cuba, 1839, "Foraminifères," p. 18.
Triplasia REUSS, Denkschr. Akad. Wiss. Wien, vol. 7, abth. 1, 1854, p. 65.
Rhabdogonium REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 198.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 524.

Description.—Test elongate, triangular or quadrangular in cross section, chambers numerous, uniserial or somewhat irregular; wall hyaline, surface smooth or roughened, aperture at the end of a short tubular neck.

There has been some dispute as to the names for this genus. D'Orbigny applied the name *Vaginulina* to a species of this genus, but as this name had been used previously in a different sense it is not available here. He also described *Orthocerina*, but the original species described under this genus is probably a *Clavulina* as nearly as can be determined. Therefore it can not be used here. The next name, *Triplasia*, was used by Reuss for three-angled species. *Rhabdogonium* was a later name which he used because four-angled species had been found and Reuss thought *Rhabdogonium* a more appropriate name. He put *Triplasia* as a synonym of *Rhabdogonium* and places there his type species of *Triplasia* (*Triplasia murchisonii*). As a result it seems that *Triplasia* must, by all laws of priority, be used instead of *Rhabdogonium*.

TRIPLASIA TRICARINATA (d'Orbigny).

Plate 39, fig. 2.

Vaginulina tricarinata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 258 No. 4; Modèles, No. 4.
Rhabdogonium tricarinatum H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 525, pl. 67, fig. 1–3.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 752, pl. 15, fig. 16.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 45, fig. 3.—SCHRODT, Zeitschr. deutsch. geol. Ges., vol. 42, 1890, p. 411, pl. 22, fig. 2.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 558, pl. 10, fig. 7.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 484.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 355, pl. 11, figs. 49, 50; pl. 12, figs. 36–38.—CHAPMAN, Proc. Zool. Soc., London, 1895, p. 33.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 12, 1896, p. 194, pl. 1, fig. 8.—MILLETT, Journ. Micr. Soc., 1902, p. 525.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 145.

Description.—Test elongate, slightly tapering toward either end, often somewhat twisted, triangular in cross section, aperture in the center at the end of the chamber, usually with a short tubular neck and phialine lip; angles of the test carinate.

Length about 0.4 mm.

Distribution.—The *Challenger*, from Brady's records, did not obtain this species from the North Pacific. Goës records it at *Albatross* station 3395 in 730 fathoms. Bagg found it from about the Hawaiian Islands at 13 *Albatross* stations, very abundant, ranging in depth from 104 to 1,544 fathoms. I have obtained it from a number of stations about the Hawaiian Islands, off the west coast of America, and Guam, and off Japan, depths ranging from 181 to 1,355 fathoms.

TRIPLASIA REUSSII, new name.

Plate 39, fig. 3.

Rhabdogonium minutum H. B. Brady (not *R. minutum* Reuss), Rep. Voy. *Challenger*, Zoology, vol 9, 1884, p. 526, pl. 67, figs. 4–6.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 145.—Chapman, Journ. Linn. Soc. London, Zool., vol. 30, 1910, p. 412 [?].

Description.—Test thick and short, triangular in cross section, chambers few, somewhat elongate, somewhat carinate, walls roughish, thick; aperture with a short neck, fairly large, often with a fringe-like cutting about the opening.

Length, about 0.8 mm.

Distribution.—Brady found this species off the Ki Islands, southwest of New Guinea, 129 fathoms. Bagg records it from several stations about the Hawaiian Islands in 104 to 1,544 fathoms.

This species is rare in the North Pacific. It can easily be distinguished from *T. tricarinatum* by its more irregular form, short, thick chambers, roughened surface, and different apertural characters.

To unite this recent tropical species with *Rhabdogònium minutum* Reuss is rather a difficult problem, as Reuss's figure shows a compressed form entirely different in all its general characters. As the recent species seems to be entirely distinct from the fossil species described by Reuss from Galicia, a new name is here given to the recent species.

Genus CRISTELLARIA Lamarck, 1812.

Nautilus (part) Linnæus, Syst. Nat., ed. 12, 1767, p. 1162.

Lenticulites (part) Lamarck, Annales du Muséum, vol. 5, 1804, p. 188.

Cristellaria Lamarck, (Type, *Cristellaria calcar* (Linnæus)) Extract Cours Zool., 1812, p. 122.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 534.

Description.—Test planospiral, typically close coiled, but becoming much uncoiled in some species; chambers numerous; wall hyaline, perforate; variously ornamented; aperture usually distinctly radiate.

This genus is one of the most interesting of the various genera of the Lagenidæ. It shows a great range of characters along several lines. The test may be close coiled typically, but in some species becomes uncoiled early, and the resulting development is often almost

Nodosarian, but the chambers usually keep an oblique tendency and the sutures usually oblique, at least in side view. Some species are very much compressed, while others are tumid or strongly umbonate. The surface of the test may be smooth or it may be variously ornamented with costæ, limbate sutures, knobs and bosses, spines or combinations of them and often the peripheral border is broadly keeled. Altogether except for *Lagena* it presents a greater range of ornamentation than any genus of the Lagenidæ. The aperture is usually very characteristic, being distinctly radiate and in some species being visible in many of the earlier chambers even when adult size is reached.

The genus is widely distributed geographically and bathymetrically, although it undoubtedly reaches its greatest development in comparatively shallow water—less than 500 fathoms—in rather warm waters, as about tropical islands. It is, however, found in great numbers in colder waters, but the species are fewer in number and lack the extravagant ornamentation seen in the tropical species. Geologically the range of the genus is a long one, its earliest limits not being satisfactorily determined.

There are several names of Montfort which were used previously to the use of *Cristellaria* by Lamarck, but these are ill defined and the poorly executed figures makes it impossible without a study of the types to say just what species the author had in mind. With such an ill-defined condition it seems ill advised at the present time to replace *Cristellaria* with any of Montfort's names. With a study of the types it may be necessary to do this.

CRISTELLARIA CULTRATA (Montfort).

Plate 29, fig. 4.

"Cornu Hammonis" Plancus, Conch. Min., 1760, p. 120, pl. 1, fig. 12.

"Nautili (*Lenticulae marginatae*)" Soldani, Testaceographia, vol. 1, pt. 1, 1789, p. 54, pl. 33, fig. B.

Robulus cultratus Montfort, [?] Conch. Syst., vol. 1, 1808, p. 214, 54ᵉ genre.

Robulina cultrata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 287, No. 1; Modèles, No. 82; Foram. Foss. Bass. Tert. Vienne, 1846, p. 96, pl. 4, figs. 14, 15.

Cristellaria cultrata Parker and Jones, Philos. Trans., vol. 155, 1865, p. 344, pls. 13, 17, 18; pl. 16, fig. 5.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 550, pl. 70, figs. 4, 5, 6.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 352, pl. 12, figs. 8–10, 24, 25.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 318, pl. 65, fig. 2.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 147.

Description.—Test very similar to that of *C. rotulata*, but with the added character of a peripheral keel of greater or less extent.

Length up to 4 mm.

Distribution.—Brady records this species from a single North Pacific station, off the Philippines in 95 fathoms. Bagg records it from three *Albatross* stations, off the Hawaiian Islands; D4000 in 104–213 fathoms; H4566 in 572 fathoms; and H4696 in 367 fathoms.

Fine large specimens occur off the Pacific coast of the United States and in Bering Sea in comparatively shallow cold water. Occasional specimens occur off Japan being common at one station, *Albatross* D5056 in 258 fathoms, bottom temperature 46° F. It also occurred off the Hawaiian Islands, *Albatross* H3007 in 323 fathoms.

The main distinguishing character between this species and *C. rotulata* is the presence of the broad keel in *C. cultrata.* The distribution, at least so far as is shown by the North Pacific material examined, is by no means coextensive in the two species.

CRISTELLARIA RENIFORMIS d'Orbigny.

Plate 30, fig. 4; plate 33, fig. 1.

Cristellaria reniformis D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 88, pl. 3, figs. 39, 40.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 539, pl. 70, figs. 3*a*, *b*.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 315, pl. 62, fig. 2.—BAGG, Bull. 513, U. S. Geol. Survey, 1912, p. 66, pl. 19, figs. 2*a*, *b*.

Description.—Test compressed, somewhat elongated, early chambers forming a close coiled test, later chambers becoming longer and a tendency toward an elongate form is shown, with oblique sutures; wall smooth; peripheral border slightly to strongly keeled; aperture often slightly produced, radiate.

Length up to 5 mm.

Distribution.—Brady records this species from the North Pacific in 2,050 fathoms in the *Challenger* report, but in the volume on the Summary of Results it is also recorded from *Challenger* station 237 in 1,875 fathoms. I have had material which seems to belong to this species from three *Albatross* stations, D4310, D4972 in 440 fathoms, bottom temperature 39.8° F., and D5078 in 514 fathoms, bottom temperature 38.9° F., off Japan. It also occurred at *Nero* station 1302 in 1,331 fathoms, also off Japan.

CRISTELLARIA ARTICULATA Reuss.

Plate 31, fig. 1.

Robulina articulata REUSS, Sitz. Akad. Wiss. Wien, vol. 48, 1863, p. 53, pl. 5, fig. 62.

Cristellaria articulata REUSS, Sitz. Akad. Wiss. Wien, vol. 62, 1870, p. 483.—VON SCHLICHT, Foram. Pietzpuhl, 1870, pl. 17, figs. 5–12.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 547, pl. 69, figs. 10–12.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 317, pl. 64, fig. 2.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 146.

Description.—Test close coiled, nearly circular in side view, thick, chambers tumid, sutures depressed; periphery obtusely angled; aperture exserted, broad and rounded in side view, radiate; umbonal portion of test often of clear shell material.

Length up to 3 mm.

Distribution.—Bagg records this species from a single *Albatross* station H4696 in 376 fathoms off the Hawaiian Islands. I have had material from four stations, all off Japan; H4882 in 248 fathoms, bottom temperature 48.8° F.; D4893 in 106 fathoms, bottom temperature 55.9° F.; D4895 in 95 fathoms; and D4964 in 37 fathoms, bottom temperature 66.6° F.

CRISTELLARIA ROTULATA (Lamarck).

Plate 35, fig. 3.

"Cornu Hammonis seu Nautili" Plancus, Conch. Min., 1739, p. 13, pl. 1, fig. III.

Lenticulites rotulata Lamarck, Ann. Mus., vol. 5, 1804, p. 188, No. 3; vol. 8, 1806, pl. 62, fig. 11.

Cristellaria rotulata d'Orbigny, Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 26, pl. 2, figs. 16–18.—Parker and Jones, Philos. Trans., vol. 155, 1865, p. 345, pl. 13, fig. 19.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 547, pl. 69, figs. 13*a*, *b*.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 224, pl. 64, fig. 15.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 351, pl. 12, figs. 1, 2, 32, 33.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 3, 1893, p. 435, pl. 2, fig. 11; vol. 4, 1894, p. 221, pl. 3, figs. 24, 25.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 60, pl. 10, figs. 559–578; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 54.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 317, pl. 64, fig. 4.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 148; Bull. 513, U. S. Geol. Surv., 1912, p. 67, pl. 19, figs. 5*a*, *b*.

Description.—Test large, close coiled, chambers numerous, lenticular, biconvex; wall smooth, thick; peripheral margin rather acute, but not distinctly carinate; apertures of all chambers of visible test usually apparent.

Length 1.5 to 4 mm.

Distribution.—Brady records this species from a single North Pacific *Challenger* station 232 in 345 fathoms south of Japan. Goës records it from seven *Albatross* stations in the eastern Pacific at depths varying from 660 to 1,201 fathoms. Bagg records it from two stations near the Hawaiian Islands, *Albatross* D4000 in 104 to 213 fathoms and H4430 in 1,544 fathoms. I have had material from *Albatross* station D3346 in 19 fathoms off Alaska and from several stations near Japan, depths ranging from 437 to 712 fathoms and the bottom temperatures from 37.5° to 39.8° F.; also from several *Nero* stations in the same area.

This species seems to differ from *C. cultrata* (Montfort) in the lack of a definite keeled periphery, but many intermediate forms are found, and such specimens are with difficulty placed in either one of the two extreme forms.

CRISTELLARIA NITIDA d'Orbigny.

Plate 32, fig. 2.

"Nautili Lituitati" SOLDANI, Testaceographia, vol. 1, pt. 1, 1789, p. 64, pl. 64, figs. O, P.

Cristellaria nitida D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 291, No. 5.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 549, pl. 70, figs. 2*a*, *b*.

Description.—"A feeble modification belonging to the '*cassis*' and '*mamilligera*' group. The shell is compressed and carinate and the earlier sutures limbate. It is a doubtful and unsatisfactory species."

Length 1.4 mm.

Distribution.—The only record for this somewhat doubtful species in the North Pacific is that given by Brady in the *Challenger* Report, 95 fathoms off the Philippines.

The description and figure are taken from the *Challenger* Report.

CRISTELLARIA ORBICULARIS (d'Orbigny).

Plate 36, figs. 4, 5.

"Nuclei conico rotundati" SOLDANI, Testaceographia, vol. 2, 1798, App., p. 138, pl. 1, fig. 12. *p*, P.

Robulina orbicularis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 288, pl. 15, figs. 8, 9.

Cristellaria orbicularis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 549, pl. 69, fig. 17.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 317, pl. 64, fig. 3.—[?] BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 148.

Description.—Test very similar to *C. vortex*, but the periphery extended into a distinct keel, varying in width.

Length 1 to 1.5 mm.

Distribution.—Bagg records this species from *Albatross* station H4508 in 495 fathoms near the Hawaiian Islands as rare. I have material from *Albatross* stations off Japan, D4807 in 44 fathoms; D4887 in 71 fathoms, bottom temperature 59.7° F.; D4891 in 181 fathoms, bottom temperature 50.2° F.; and D4900 in 139 fathoms, bottom temperature 52.9° F. It also occurred at *Nero* station 203 in 1,625 fathoms near the Midway Islands.

This species seems to be very slightly different from *C. vortex*, except in the character of the keel. The specimens figured by Flint seem to me to be rather different in most cases from the typical form figured by d'Orbigny. The sutures are much less oblique, the chambers much shorter, and the whole seems unlike the type.

CRISTELLARIA VORTEX (Fichtel and Moll).

Plate 32, fig. 3.

"Nautili globuli" Soldani, Testaceographia, vol. 1, pt. 1, 1879, p. 66, pl. 59, fig. *tt*.

Nautilus vortex Fichtel and Moll, Test. Micr., 1803, p. 33, pl. 2, figs. *d–i*.

Polystomella vortex Blainville, Man. de Malac., 1825, p. 389.

Robulina vortex d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 288, No. 4.

Cristellaria vortex Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 240, pl. 10, fig. 82.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 548, pl. 69, figs. 14–16.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 317, pl. 65, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 148.

Description.—Test close coiled, biconvex, umbonate; chambers elongate, curved, the sutures making a long curve from the periphery to the umbo; peripheral margin acute but not distinctly carinate; wall smooth.

Length 1 to 1.5 mm.

Distribution.—Bagg records this species from a single *Albatross* station H4508 in 495 fathoms off the Hawaiian Islands. I have had specimens from *Albatross* H3007 in 323 fathoms also off the Hawaiian Islands and *Nero* station 990 in 859 fathoms off Guam.

CRISTELLARIA CONVERGENS Bornemann.

Plate 34, fig. 3.

Cristellaria convergens Bornemann, Zeitschr. deutsch. Geol. Ges., vol. 7, 1855, p. 327, pl. 13, figs. 16, 17.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 546, pl. 69, figs. 6, 7.

Description.—Test oval, biconvex, close coiled; chambers triangular, the last formed one drawn out to a point at the apertural end; sutures hardly visible, the chambers embracing to the umbo; wall smooth and thick.

Length about 1 mm.

Distribution.—Brady records this species at a single *Challenger* station 224 in 1,850 fathoms in the North Pacific. I have had material referable to this species from numerous stations, most of them off Japan. It occurred at two *Nero* stations 1208 in 665 fathoms and 1213 in 808 fathoms off Yokohama and at numerous *Albatross* stations in the same region with a range of depth from 361 to 649 fathoms, the bottom temperatures ranging from 38.1° F. to 42.7° F. The species also occurred at one *Tuscarora* station No. 58 in 814 fathoms, lat. 26° 52′ N., and long. 142° 21′ E.

The most striking characters of this species are the extension of the alar projections laterally over the sides of the test with a consequent obscuring of the sutural lines.

CRISTELLARIA ACUTAURICULARIS (Fichtel and Moll).

Plate 35, fig. 2.

"Hammoniæ subrotundæ" Soldani, Testaceographia, vol. 1, pt. 1, 1789, p. 61, pl. 49, fig. X.

Nautilus acutauricularis Fichtel and Moll, Test. Micr., 1803, p. 102, pl. 18, figs. *g–i*.

Cristellaria acutauricularis Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 114.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 543, pl. 114, figs. 17*a*, *b*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 353, pl. 12, figs. 19, 20.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 316, pl. 63, fig. 5.

Description.—Test thick, slightly elongate; early chambers close coiled, later ones elongate and oblique; sutures somewhat depressed; wall smooth, apertural end rather pointed.

Length less than 1 mm.

Distribution.—The only published record for this species in the North Pacific is that of Brady in the *Challenger* Report. It occurred off the Philippines in 95 fathoms. I have had material referable to this species only from *Nero* 2055 in 536 fathoms near the Hawaiian Islands.

This species is close to *C. crepidula*, from which it seems to differ only in the less compressed and less elongate form of the test.

CRISTELLARIA GIBBA d'Orbigny.

Plate 35, fig. 1.

Cristellaria gibba d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 63, pl. 7, figs. 20, 21.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 546, pl. 69, figs. 8, 9.—Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 259, pl. 10, figs. 19, 21.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 352, pl. 12, figs. 21, 27.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 61, pl. 10, figs. 287, 288.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 4, 1894, p. 221, pl. 3, fig. 20.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 55.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 317, pl. 64, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 147.

Description.—Somewhat oval; biconvex; inner face decidedly contracted; peripheral margin somewhat keeled; wall smooth; sutures not depressed; apertures of earlier chambers usually apparent, even in adult condition.

Length usually 1 to 1.5 mm.

Distribution.—Goës records this species from a single *Albatross* station in the eastern Pacific, D3376 in 1,132 fathoms. Bagg records it from two stations off the Hawaiian Islands, *Albatross* D4000 in 104 to 213 fathoms and H4694 in 865 fathoms. I have had material from one *Nero* station, 2055 off the Hawaiian Islands in 536 fathoms and from three *Albatross* stations off Japan, D4958 in 405 fathoms, bottom temperature 40.1° F.; D5055 in 124 fathoms, bottom temperature 56.6° F.; and H4882 in 248 fathoms, bottom temperature

48.8° F. It also occurred at *Tuscarora* station 1, lat. 27° 7′ N., and long. 142° 7′ E. in 73 fathoms.

CRISTELLARIA VARIABILIS Reuss.

Plate 36, figs. 1–3.

Cristellaria variabilis Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 369, pl. 46, figs. 15, 16.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 541, pl. 68, figs. 11–16.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 224, pl. 44, fig. 12.—Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 560, pl. 10, fig. 22.—Egger, Abh. kön. bay. Akad. Wiss., München, Cl. ii, vol. 18, 1893, p. 353, pl. 12, figs. 16–18.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 1894, p. 62, pl. 10, figs. 593–595.—Flint, Rep. U. S. Nat. Mus., p. 316, pl. 63, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1903, p. 256, pl. 5, fig. 1.

Description.—Test compressed, varying in form according to stage in development, early stages nearly circular, later becoming elliptical or oblong; chambers comparatively few, high and broad; surface smooth, sutures very slightly depressed, in adult specimens the periphery keeled; aperture in adults somewhat produced, the outer border irregularly dentate.

Length usually not much exceeding 1 mm.

Distribution.—Brady records this species from a single *Challenger* station, 232, on the *Hyalonema*-ground, south of Japan in 345 fathoms. I have had it from but four stations, *Albatross* stations off Japan, D4897, 207 fathoms, bottom temperature 49.7° F.; D4949, 110 fathoms, bottom temperature 57.8° F.; D4970 in 500 fathoms, bottom temperature 39.1° F.; and D5056 in Suruga Gulf, Japan, 258 fathoms, bottom temperature 46.0° F.

This species is distinct from most others of the genus in its few high, broad chambers, taking but a very few to make a complete convolution and in the peculiar form of the aperture with its almost ragged appearance at the periphery.

CRISTELLARIA CREPIDULA (Fichtel and Moll).

Plate 29, figs. 5, 6; plate 31, figs. 2–5.

Nautilus crepidula Fichtel and Moll, Test. Micr., 1803, p. 107, pl. 19, figs. *g–i*.

Cristellaria crepidula d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 64, pl. 8, figs. 17, 18.—Parker and Jones, Philos. Trans., vol. 155, 1865, p. 344, pl. 13, figs. 15, 16; pl. 16, fig. 4.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 542, pl. 67, figs. 17, 19, 20; pl. 68, figs. 1, 2.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 4, vol. 10, 1890, p. 471, pl. 2, figs. 31–33, 56–60.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 350, pl. 11, figs. 51, 52; pl. 12, figs. 34, 35.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 62, pl. 11, figs. 599, 600; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 57.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 316, pl. 63, fig. 2.—Millett, Journ. Roy. Micr. Soc., 1903, p. 254.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 7, pl. 2, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 146.

Description.—Test elongate, compressed, early chambers close coiled, later ones becoming uncoiled, elongate; sutures slightly depressed; wall smooth; periphery rounded, without a keel.

Length up to 3 mm.

Distribution.—Brady records this species from 40 fathoms off the coral reefs of Honolulu, Hawaiian Islands, and in the *Challenger* volume on "Summary of Results," it is also recorded from *Challenger* station 246 in 2,050 fathoms. Goës records it from two *Albatross* stations, D3375 and D3376, in 1,201 and 1,132 fathoms, respectively, in the eastern Pacific. Bagg records it at four *Albatross* stations in the vicinity of the Hawaiian Islands; D4000 in 104–213 fathoms; H4430 in 1,544 fathoms; H4508 in 495 fathoms; and H4694 in 865 fathoms.

I have had specimens from numerous *Nero* stations about the Hawaiian Islands, west of Midway Island, and between Guam and Japan, ranging in depth from 518 to 2,080 fathoms. Off the Galapagos I have had it from D2806 in 1,379 fathoms, and off Japan at the following stations: D4949 in 110 fathoms, bottom temperature 57.8° F.; D4966 in 290 fathoms, bottom temperature 44.1° F.; and D4967 in 244 fathoms, bottom temperature 45.9° F.

CRISTELLARIA LATA (Cornuel).

Plate 35, fig. 4.

Marginulina lata Cornuel, Mém. Soc. géol. France, ser. 2, vol. 3, 1848, p. 252, pl. 1, figs. 34–37.

Planularia pauperata Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 454, pl. 20, fig. 39.—H. B. Brady, Proc. Somerset Arch. and Nat. Hist. Soc., vol. 13, 1867, p. 110, pl. 2, figs. 24, 25.

Cristellaria lata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 539, pl. 67, fig. 18*a*, *b*.

Description.—Test broad, subtriangular in side view, much compressed, early chambers somewhat close coiled, later ones very elongate and uncoiling, sutures very slightly depressed, oblique, wall smooth, aperture somewhat produced, radiate.

Length up to 2 mm.

Distribution.—This species has been previously unrecorded from the North Pacific. I have had specimens from the three following stations, *Albatross* D4843, in 100 fathoms, bottom temperature 39.9° F., off Japan, and *Tuscarora* 11, in 437 fathoms, lat. 33° 46′ N.; long. 140° 21′ E. and *Tuscarora* 126, in 500 fathoms, lat. 54° 08′ N.; long. 161° 31′ W.

This species seems to be a broadened development of a form like *C. crepidula*, but seems to have characters which make it distinct from that species.

CRISTELLARIA TRICARINELLA Reuss.

Plate 34, figs. 1, 2.

Cristellaria tricarinella Reuss, Sitz. Akad. Wiss. Wien, vol. 46, 1862, p 68, pl. 7, fig. 9; pl. 12, figs. 2-4.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 540, pl. 68, figs. 3, 4.

Description.—Test elongate, greatly compressed; earliest chambers close coiled, following ones soon becoming elongate, but extending back to the previous coil, giving an elongate subtriangular form to the later developed portion, sutures limbate; periphery of the test with a flange-like keel at each side, the border between them concave or with a median raised keel in addition to the lateral ones, wall unornamented except for the limbate sutures and keeled periphery.

Length 1.5–2 mm.

Distribution.—Brady records this species in the North Pacific from one *Challenger* station off the Philippines in 95 fathoms. The only North Pacific stations from which I have had material are *Albatross* D4840 in 154 fathoms, bottom temperature 39.9° F., and D4900 in 139 fathoms, bottom temperature 52.9° F., off Japan. This is the same region from which so many southern species seem to reach their northern limits, that it is not surprising to find this species there, which is really from its distribution a species of tropical waters.

CRISTELLARIA TRICARINELLA Reuss, var. SPINIPES, new variety.

Plate 33, fig. 2.

Description.—Like the typical but the early chambers of the close coiled portion showing limbate sutures and the apical end of the test bearing a large stout spine.

Type-specimen.—Cat. No. 8546, U.S.N.M., from *Albatross* station D4900 in 139 fathoms, bottom temperature 52.9° F., off Japan.

CRISTELLARIA CALCAR (Linnæus).

Plate 32, fig. 4.

"Nautilus minimus non umbilicatus" Gaultieri, Index Test., 1742, pl. 19, fig. C.

"Nautili (Lenticulæ radiatæ)" Soldani, Testaceographia, vol. 1, pt. 1, 1789, p. 54, pl. 33, figs. *aa*, *bb*.

Nautilus calcar Linnæus, Syst. Nat., ed. 12, 1767, p. 1162, No. 272; (Gmelin's) ed. 13, 1788, p. 3370, No. 2.

Robulina calcar d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 99, pl. 4, figs. 18–20.

Cristellaria calcar Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 289, pl. 10, figs. 10–12.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 242, pl. 10, fig. 91.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 551, pl. 70, figs. 9–15.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 224, pl. 44, fig. 14.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 318, pl. 66, fig. 1.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 10, 1902, p. 46, fig. 45.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 146.

Robulina aculeata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 289, No. 14.

Description.—Test close coiled, biconvex, umbonate; wall smooth, sutures distinct but hardly, if at all, depressed; periphery of test acute, with a distinct carina of greater or less width, with a long acicular spine opposite each chamber.

Length without spines about 1 mm.

Distribution.—Brady records this species from a single *Challenger* station in the North Pacific, 95 fathoms off the Philippines. Bagg records it from an *Albatross* station D4000 in 104 to 213 fathoms off the Hawaiian Islands. I have had specimens from one *Albatross* station H2922 in 268 fathoms and *Nero* station 2071 in 271 fathoms off the Hawaiian Islands and from several stations off Japan, depths ranging from 37 to 139 fathoms and bottom temperatures from 52.9° to 66.6° F. It is interesting to note that one of these stations, D4900, is one from which so many species recorded by Brady from the Philippines have been obtained.

From the above data the distribution of this species in the North Pacific at least seems to be largely in comparatively shallow, warm waters.

There seem to be two distinct forms at least which are included under this specific name. One of these is small in size, of comparatively few chambers in each whorl and with a few long acicular spines radially placed, the peripheral carina being narrow. The other is of much larger size, with many more chambers in each whorl and with many short broad flattened spinose projections extending somewhat backward from the wide peripheral carina and appearing as projections of the carina rather than as distinct spines.

The small form with the long acicular spines is the only one which I have seen in the North Pacific material. The synonymy is not clear on these two forms and it will be interesting to see if these are not really distinct from one another. The figures given by Flint show well the contrast in size and other characters between these two forms.

CRISTELLARIA ECHINATA (d'Orbigny).

Plate 34, fig. 5.

"Nautili Echinati" etc. SOLDANI, Testaceographia, vol. 1, pt. 1, 1789, p. 65, pl. 59, figs. *qq*, *rr*.

Nautilus calcar, var. e, FICHTEL and MOLL, Test. Micr., 1803, p. 74, pl. 12, figs. *a*, *b*, *c*.

Robulina echinata D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 100, pl. 4, figs. 21, 22.

Cristellaria (*Robulina*) *echinata* CARPENTER, PARKER, and JONES, Intr. Foram., 1862, pl. 12, fig. 3.

Cristellaria echinata H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 554, pl. 71, figs. 1–3.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 318, pl. 66, fig. 2.

Description.—Test close coiled, composed of comparatively few chambers, biconvex, umbonate; sutures limbate, in the earlier development tending to break up into a series of raised rounded bosses, the largest near the umbo and thence diminishing in size toward the periphery, in the last-formed chambers the whole becoming a single raised ridge; wall between the sutures in the earlier development closely set with small raised papillæ becoming less numerous or wanting on the later-formed chambers; periphery with a slight keel and each chamber with a long acicular spine.

Length without spines about 2 mm.

Distribution.—The only North Pacific record for this beautiful species is that given by Brady, a single *Challenger* station off the Philippines in 95 fathoms.

This species combines many of the characters of *C. calcar* and *C. papillosa.*

CRISTELLARIA PAPILLOSA (Fichtel and Moll).

Plate 37, fig. 2.

Nautilus papillosus Fichtel and Moll, Test. Micr., 1803, p. 82, pl. 14, figs. *a–c.*
Cristellaria papillosa Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 113, No. 17.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 553, pl. 70, fig. 16.

Description.—Test close coiled, composed of numerous chambers, peripheral margin acute but not distinctly carinate; biconvex, sutures limbate, the thickenings developing into a series of rounded knobs, largest near the umbo and gradually decreasing in size toward the periphery; the wall in the earlier development between the sutures is more or less covered with fine raised papillæ, but these are not developed in the last-formed chambers.

Length about 2 mm.

Distribution.—This species has not previously been recorded from the North Pacific. The only material I have had is from the Inland Sea of Japan, depth not recorded. It is typical.

CRISTELLARIA MAMILLIGERA Karrer.

Plate 34, fig. 6.

Cristellaria mamilligera Karrer, *Novara* Exped., Geol. Theil., vol. 1, pt. 2, 1864, p. 76, pl. 16, fig. 5.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, p. 553, pl. 70, figs. 17, 18.

Description.—Test close coiled, composed of numerous, comparatively long-tapering chambers, sutures limbate, occasionally enlarging into rounded bosses at the inner end; test biconvex, somewhat umbonate; peripheral margin extended into a well-developed carina.

Length up to 2 mm.

Distribution.—Brady records this species in the North Pacific from a single *Challenger* station, 95 fathoms, off the Philippines. I have had material only from *Albatross* station D4900, off Japan, in 139 fathoms, bottom temperature 52.9° F. This is another example of the extension of the species recorded by Brady from the Philippines to southern Japan at this particular station.

CRISTELLARIA DENTICULIFERA, new species.

Plate 37, fig. 1.

Cristellaria cultrata H. B. Brady (part) (not *C. cultrata* Montfort), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 550, pl. 70, figs. 7, 8.

Description.—Test close coiled, biconvex, sutures somewhat limbate; wall of earlier chambers ornamented with longitudinal curved costæ often broken up into irregular tubercles; later chambers smooth and unornamented; peripheral border keeled, but the outer edge broken up into a series of tooth-like projections.

Length up to 2.5 mm.

Type-specimen.—Cat. No. 8547, U.S.N.M., from *Albatross* station D4900 in 139 fathoms, bottom temperature 52.9° F. off Japan.

This certainly seems to be a different species from typical *C. cultrata.* It differs in the limbate sutures, the smaller number of chambers in the coil, the surface ornamentation, and the denticulate character of the peripheral keel.

CRISTELLARIA GEMMATA H. B. Brady.

Plate 34, fig. 7.

Cristellaria gemmata H. B. Brady, Quart. Journ. Micr. Soc., vol. 21, 1881, p. 64, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 554, pl. 71, figs. 6, 7.

Description.—"Test planospiral, broad, oblong, compressed or complanate; lateral faces only slightly convex, dorsal edge acute or subcarinate; segments broad and arcuate, two or three of later ones free at both lateral margins; exterior ornamented with exogenous beads, arranged either upon the sutural lines, or, less frequently, in rows parallel to them."

"Length 1/20th inch (1.26 mm.)."

Distribution.—The only North Pacific record for this species is that given by Brady, a *Challenger* station off the Philippines in 95 fathoms.

CRISTELLARIA COSTATA (Fichtel and Moll).

Plate 34, fig. 4.

Nautilus costatus Fichtel and Moll, Test. Micr., 1803, p. 47, pl. 4, figs. *g–i*.
Spincterules costatus Montfort, Conch. Syst., 1808, p. 222, genre 56^e.
Lenticulina costata De France, Dict. Sci. Nat., vol. 32, 1824, p. 182.
Robulina costata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 289, No. 13 [?].
Cristellaria costata Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 113, No. 19.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 555, pl. 71, figs. 8, 9.

Description.—Test close coiled, chambers comparatively few to each volution, sutures limbate; surface ornamented by numerous stout costæ in general parallel with the periphery of the test; apertural angle decidedly acute.

Length about 1 mm.

Distribution.—This species has not previously been reported from the North Pacific. The only material I have seen is from *Nero* station 203 in 1,625 fathoms, bottom temperature 35° F., west of Midway Islands.

This is a remarkable occurrence for this species, which by its previous recorded distribution seems to have been taken in comparatively warm and shallow water.

CRISTELLARIA ELEGANTISSIMA (Costa).

Plate 36, fig. 7.

Robulina elegantissima Costa, Atti Accad. Pont., vol. 7, pt. 2, 1856, p. 198, pl. 19, fig. 4.

Cristellaria elegantissima Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 64, pl. 11, figs. 641, 642.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 147.

Description.—Test compressed with the earlier development close coiled, later chambers elongate, taking on a tendency toward uncoiling, early chambers ornamented with closely set, rather acute costæ, parallel to the periphery of the test, sutures indistinct, not limbate; later chambers smooth, ornamentation persisting longest on the periphery; peripheral border with a narrow but very distinct keel; apertural angle prominent.

Length about 1.25 mm.

Distribution.—Bagg records this species from a single *Albatross* station, H4508, in 495 fathoms off the Hawaiian Islands. This specimen I have examined and it is here figured.

This species differs from *C. costata* in the form of the test and in the ornamentation which here is close set and rather acute while in *C. costata* the costæ are coarser and rounded.

CRISTELLARIA WETHERELLII Jones, var. SUBLINEATA, new variety.

Plate 33, fig. 4.

Description.—Test at first close coiled, later becoming uncoiled and crozier-shaped; curved; compressed, sutures depressed, portion of chamber wall between the sutures ornamented with rows of tubercles in linear rows both transversely and longitudinally, in later growth tending to fuse into a raised ridge.

Length about 5 mm.

Type-specimen.—Cat. No. 8548, U.S.N.M., from *Albatross* station D4900 in 139 fathoms, bottom temperature 52.9° F., off Japan. This is the first occurrence of this species in the North Pacific, and the form is not the typical one.

CRISTELLARIA SUBALATA H. B. Brady.

Plate 30, figs. 5–7.

Cristellaria obtusata Reuss, var. *subalata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 536, pl. 66, figs. 24, 25.

Cristellaria subarcuatula Goës (part, not *C. subarcuatula* Montagu), Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 57.

Description.—Test much elongated, earliest chambers close coiled, later ones very early becoming uncoiled and developing an elongate, compressed test, with oblique, slightly depressed sutures; wall smooth; initial end of the test, with a broad flaring plate-like keel, not extending up the peripheral margin, or at least only slightly, bearing numerous concentric lines of growth and usually with radial markings as well; aperture radiate, terminal.

Length up to 5 mm.

Distribution.—Under the name *C. subarcuatula* Goës has recorded this species from two stations in the eastern North Pacific, *Albatross* D3375, 1,201 fathoms, and D3407 in 885 fathoms.

An examination of Goës's specimens from these stations shows them to be of the form here figured rather than that shown[1] by Goës, who simply used as illustrations copies of his figures in the "Report upon the Arctic and Scandinavian Foraminifera" previously published.[2] In reality the specimens found by Goës at these North Pacific stations as is shown by Goës's own material are identical with the form figured by Brady in the *Challenger* Report as noted above. In many of its characters this form seems worthy of specific rank and its relation to *C. obtusata* Reuss is very doubtful. I have taken the liberty of raising it to specific rank.

CRISTELLARIA SCHLOENBACHI Reuss.

Plate 36, fig. 6.

Cristellaria schloenbachi Reuss, Sitz. Akad. Wiss. Wien, vol. 46, 1862, p. 65, pl. 6, figs. 14, 15.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 539, pl. 67, fig. 7.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 315, pl. 63, fig. 4.—Millett, Journ. Roy. Micr. Soc., 1903, p. 253.

Description.—Test much elongate, compressed, early portion close coiled for a few chambers, then gradually assuming an uncoiled straight form, but with the sutures oblique, the chambers high; surface smooth, sutures slightly depressed, peripheral border rounded; aperture terminal, radiate.

Length about 2 to 2.5 mm.

Distribution.—Although not previously recorded from the North Pacific, the species occurred at *Albatross* station D4875 in 59 fathoms, eastern channel of Korea Strait.

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[1] Bull. Mus. Comp. Zoöl., vol. 29, 1896, pl. 5, figs. 19–24.

[2] Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 63, pl. 11, figs. 630–637.

CRISTELLARIA LATIFRONS H. B. Brady.

Plate 38, fig. 2.

Cristellaria latifrons H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 544, pl. 68, fig. 19; pl. 113, fig. 11*a*, *b*.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 316, pl. 63, fig. 3.

Description.—Test elongate, tapering toward either end, triangular in transverse section; early chambers close coiled, later ones uncoiling elongate, very broad on the inner face, each chamber extending well back toward the preceding coil, its marginal angles acute or obtusely rounded, peripheral margin of the test angular.

Length 0.6 to 1.5 mm.

Distribution.—This species has not previously been recorded from the North Pacific. The only station from which I have had material is *Albatross* D4966 in 290 fathoms, bottom temperature 44.1° F., off Japan. The material was very typical.

In the form of the chambers this is very different from *C. italica,* in which the chambers are shorter and do not extend back to the initial whorl.

CRISTELLARIA ITALICA (De France).

Plate 33, fig. 3.

Saracenaria italica De France, Dict. Sci. Nat., vol. 32, 1824, p. 177; vol. 47, 1827, p. 344; Atlas Conch., pl. 13, fig. 6.—Blainville, Man. de Mal., 1825, p. 370, pl. 5, fig. 6.

Cristellaria (*Saracenaria*) *italica* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 293, No. 26; Modèles, Nos. 19 and 85.

Cristellaria italica Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, pp. 21, 32, pl. 1, figs. 41, 42.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 544, pl. 68, figs. 17, 18, 20–23.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 350, pl. 12, figs. 22, 23, 26, 40–42.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 4, 1894, p. 219, pl. 3, fig. 8; vol. 5, 1895, p. 12, pl. 4, fig. 28.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 316, pl. 63, fig. 6.

Description.—Test stout, trihedral, triangular in cross section, early chambers close coiled, later ones uncoiling but short, not extending back to the earlier volutions; sutures somewhat depressed; wall smooth; face of the last formed chamber nearly triangular.

Length of North Pacific specimens usually less than 2 mm.

Distribution.—Apparently this species has not been recorded from the North Pacific. I have had specimens from but two *Albatross* stations, D4874 in 66 fathoms and D4972 in 440 fathoms, bottom temperature 39.8° F., both off Japan. At both these stations the specimens were small.

Genus MARGINULINA d'Orbigny, 1826.

Marginulina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 258 (type, *M. glabra* d'Orbigny).—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 526.

Description.—Test subcylindrical, early portion close coiled, later chambers uncoiled, rounded in transverse section, last formed chambers often inflated; aperture in early chambers marginal, later often becoming nearly median, usually radiate.

This genus is not well characterized, and the limits between it and the much uncoiled species of *Cristellaria* are not at all well defined.

MARGINULINA GLABRA d'Orbigny.

Plate 23, fig. 3.

Marginulina glabra D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 259, No. 6; Modèles, No. 55.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 27, pl. 1, fig. 36.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 527, pl. 65, figs. 5, 6.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 344, pl. 12, figs. 24, 25.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 346, pl. 11, figs. 28, 29.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 313, pl. 60, fig. 1.

Vaginulina glabra GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 59.

Description.—Test short, stout, early chambers close coiled, later ones uncoiled, subcylindrical, inflated, sutures depressed, surface smooth; aperture usually radiate.

Length up to 2.5 mm.

Distribution.—Brady records this species from two *Challenger* stations in the North Pacific off Japan in 345 and 2,150 fathoms. Goës records it from *Albatross* station D3376 in 1,132 fathoms off the west coast of America. I have found it but very rarely in the material I have examined.

MARGINULINA STRIATULA, new species.

Plate 23, fig. 4.

Description.—Test elongate, early part forming a portion of a coil, later chambers moniliform, tumid, separated by deep constrictions; wall with numerous very fine longitudinal striæ; aperture at the end of a well developed neck, four-radiate.

Length nearly 2 mm.

Type-specimen.—Cat. No. 8549, U.S.N.M., from *Nero* station 2071 in 271 fathoms off the Hawaiian Islands.

The finely striate surface and the apertural characters will easily distinguish the species.

Genus VAGINULINA d'Orbigny, 1826.

Vaginulina d'Orbigny (type *V. legumen* Linnæus), Ann. Sci. Nat., vol. 7, 1826, p. 257.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 529.

Description.—Test elongate, chambers in a linear series, placed so that the sutures are oblique, aperture marginal, chambers laterally compressed.

The genus *Vaginulina* is a more or less convenient one for certain compressed forms which have, in common, oblique sutures and a marginal aperture. Among the fossil forms this genus has no definite position, but its place as a genus, including recent species, is not a very stable one.

VAGINULINA LEGUMEN (Linnæus)

Plate 39, fig. 4.

Nautilus legumen Linnæus, Syst. Nat., ed. 10, 1758, p. 711, No. 248; ed. 12, 1767, p. 1164, No. 288.

Vaginulina legumen d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 257, No. 2.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 530, pl. 66, figs. 13–15.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 58.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 314, pl. 60, fig. 2.—Bagg, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 145.

Description.—Test compressed laterally, composed of several chambers, sutures distinct, often the wall below being translucent, earlier not distinguishable in contour, later ones often somewhat tumid and distinguishable, length of individual chamber variable; initial end with or without a spine; wall smooth and polished, aperture marginal on a somewhat extended neck, radiate.

Length 2 mm. or more.

Distribution.—This species is recorded by Bagg at *Albatross* station D4174 in 735 to 865 fathoms and H4567 in 1,307 fathoms off the Hawaiian Islands. I have had specimens from *Nero* station 1254 in 264 fathoms and station 1464 in 891 fathoms and from Guam and Japan.

This species is somewhat variable in length of chamber and in the presence or absence of the terminal spine.

VAGINULINA PATENS H. B. Brady.

Plate 32, figs. 7, 8.

Vaginulina patens H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 533, pl. 67, figs. 15, 16.—Egger, Abh. kön. bay. Acad. Wiss. München, Cl. ii, vol. 18, 1893, p. 348, pl. 11, figs. 44–47 [?].

Description.—"Test elongate, complanate, broadest near the middle, tapering to a point at the apertural end; aboral end broad and rounded, but finishing in a short, stout spine. Dorsal edge thin, nearly straight, ventral margin thickest near the middle, square or somewhat bicarinate.

Segments about 12 in number; long, narrow, slightly bent; obliquely set or nearly erect."

"Length $\frac{1}{35}$ inch (0.74 mm.)."

Distribution.—Described and figured by Brady from specimens dredged by the *Challenger* in 95 fathoms off the Philippines. The specimens figured by Egger seem rather doubtfully the same as Brady's, but the figures lack detail.

VAGINULINA PROTUMIDA (Schwager).

Plate 30, fig. 1.

Nodosaria protumida Schwager, *Novara* Exped., Geol. Theil. vol. 2, 1866, p. 227, pl. 6, fig. 59.

Description.—Test elongate, tapering, arcuate, early chambers somewhat oblique, sutures indistinct, later chambers much inflated; wall ornamented with numerous longitudinal raised costæ, increasing in number as chambers are added; apical portion very tapering; aperture at the end of a long slender neck.

Length about 3 mm.

Distribution.—Schwager described this species from the Tertiary of Kar Nicobar. The figured specimen is from *Albatross* station D4966, off Japan in 290 fathoms, bottom temperature 44.1° F.

Evidently this belongs to *Vaginulina* rather than *Nodosaria.* The apertural neck in the figured specimen is broken, but otherwise it agrees very well with Schwager's figure.

Genus FRONDICULARIA De France, 1824.

Frondicularia De France (type, *F. complanata* De France), Dict. Sci. Nat., vol. 32, 1824, p. 178.

Description.—Test compressed, in the adult consisting of chambers, elongate and narrow, running back on either side of the test; wall vitreous, finely perforate; aperture single, either radiate or surrounded with a lip which is usually cut in a radial manner; surface smooth or ornamented with costæ; microspheric specimens with a coiled development in the earlier chambers; megalospheric specimens without the coiled chambers as a rule.

The genus *Frondicularia* is interesting in showing very clearly the differences between the microspheric and megalospheric forms in the same species. Formerly the coiled microspheric forms were called *Flabellina,* but it has been shown that instead of generic differences these early stages represent the complete phylogenetic development seen in so many species only in the microspheric form. In the megalospheric form with its much larger proloculum the coiled chambers are few or are not developed at all. This difference in the development is shown in the accompanying outline figures.

As a fossil genus *Frondicularia* is very well represented from the Triassic onward, being very abundant, both in number of species and individuals in some horizons. In the present ocean, except in certain restricted regions, it is almost unknown. There are but few living species

FRONDICULARIA BRADYI, new name.

Plate 23, fig. 5; plate 39, fig. 5.

Frondicularia spathulata H. B. Brady (not *F. spathulata* Williamson) Quart. Journ. Micr. Sci., vol. 19, 1879, p. 56, pl. 8, figs. 5*a*, *b;* Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 519, pl. 65, fig. 18.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 5, pl. 1, fig. 26.

Description.—Test elongate, compressed, narrow; chambers comparatively few in number, proloculum largest, elliptical, more rotund than the later chambers; chambers following the proloculum reflexed; those of the later development often less so; aperture terminal, elliptical; sutures slightly depressed; surface smooth.

Length about 0.5 mm.

Distribution.—Brady obtained material of this species from off the Ki Islands, 129 fathoms, and off Raine Island, 155 fathoms. In the *Challenger* Report, page 520, he also mentions the only North Pacific record, as follows: "Mr. F. W. Millett has the same from the coast of Korea, 40 fathoms." Sidebottom records the species from the coast of the island of Delos (Grecian Archipelago) as very rare. His specimen from the Bay of Palermo and Egger's single specimen from the Gazelle expedition, both of which are referred to this species, would seem best referred to *F. nitida* Terquem, as Millett has already suggested in regard to Egger's specimen. The single specimen I have had from the North Pacific and which is here figured is from *Nero* station 990 in 859 fathoms, off Guam.

The proloculum of this species is very interesting, with its very thick wall and distinct canals. The following chambers are comparatively thin walled and lack the large canals of the proloculum.

FRONDICULARIA ROBUSTA H. B. Brady.

Plate 32, figs. 5, 6.

Frondicularia robusta H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 523, pl. 66, figs. 1, 2.

Description.—"Test elongate, compressed, stoutly built; lateral margins nearly parallel, ends obtusely angular or rounded, peripheral edges thick, rounded, slightly lobulated. Segments numerous; nearly uniform in size after the initial stage, somewhat irregular in contour, comparatively little bent. Surface furnished with closely set, irregular or interrupted, longitudinal costæ."

"Length $\frac{1}{7}$ inch (3.6 mm.)."

Distribution.—Brady described this species from specimens from two localities: Off the Ki Islands, southwest of New Guinea, 129 fathoms, and on the coral reefs of Honolulu, Hawaiian Islands, 40 fathoms.

The species is a peculiar one in many respects, the ornamentation suggesting many of the Tertiary species, but the thickened form and broad rounded edges being distinct.

The figures and description are from Brady.

FRONDICULARIA ROBUSTA H. B. Brady, var. REPANDA, new variety.

Plate 29, figs. 1, 2.

Frondicularia robusta Bagg (not *F. robusta* H. B. Brady), Proc. U. S. Nat. Mus., vol. 34, 1908, p. 145.

Description.—Test compressed, broad, later chambers extending backward, giving the test a broadly fan-shaped form; otherwise like *F. robusta* H. B. Brady.

Length up to 2.5 mm.

Distribution.—Bagg's specimen is of this broad flaring form, found at *Albatross* station D4508 in 495 fathoms off the Hawaiian Islands. I have seen specimens which are here figured from *Albatross* stations H4881 (type-locality) in 316 fathoms and D4922 in 60 fathoms, off the southern part of Japan.

Type-specimen.—Cat. No. 8550, U.S.N.M.

This variety lacks the form of the typical, but has the same general character of ornamentation and rounded borders.

Subfamily 3. POLYMORPHININÆ.

Test polythalamous; chambers arranged either biserially or in an irregular spiral; surface smooth or variously ornamented; aperture usually radiate.

This subfamily includes the genus *Polymorphina* and its closely allied form *Dimorphina*.

Genus POLYMORPHINA d'Orbigny, 1826.

Polymorphina d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 265.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 557.

Description.—Test more or less rounded, usually not equilateral, chambers few, obliquely placed in a more or less spiral arrangement; aperture terminal, usually radiate; wall calcareous, perforate, either smooth or variously ornamented with spines, costæ, or tubercles.

Although there are various modifications of *Polymorphina*, the unity of the whole is very well defined, the aperture is usually radiate and the modifications are largely along the lines of ornamentation and the arrangement, number, and form of the chambers.

POLYMORPHINA LACTEA (Walker and Jacob).

Plate 34, fig. 8.

"Serpula tenuis ovalis laevis" WALKER and BOYS, Test. Min., 1784, p. 2, pl. 1, fig. 5.

"Polymorpha Subcordiformia vel Oviformia" SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, p. 114, pl. 112, figs. 11, *nn*, etc.

Serpula lactea WALKER and JACOB, Adams' Essays, ed. 2, 1798, p. 634, pl. 24, fig. 4.

Vermiculum lacteum MONTAGU, Test. Brit., 1803, p. 522.

Polymorphina lactea MAGILLIVRAY, Moll. Aberd., 1843, p. 320.—WILLIAMSON (part) Rec. For. Great Britain, 1858, p. 71, pl. 6, fig. 147.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc. London, vol. 27, 1870, p. 213, pl. 39, fig. 1 *a–c*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 559, pl. 71, fig. 11.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 561, pl. 11, fig. 9.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 486.—CRICK and SHERBORN, Journ. Northampton Nat. Hist. Soc., vol. 7, 1892, p. 71, fig. 25.—EGGER, Abh. kön. bay. Acad. Wiss. München, vol. 18, 1893, p. 308, pl. 9, figs. 8, 14, 15.—CHAPMAN, Journ. Roy. Micr. Soc., 1896, p. 9, pl. 2, fig. 3.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 119, pl. 1, fig. 7.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 261.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 9, pl. 2, fig. 11 [?].—CHAPMAN, Journ. Quekett Micr. Club, 1907, p. 131.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 149.

Description.—Test ovate, nearly symmetrical in transverse section, chambers few, elongate, separated by slightly depressed sutures; wall smooth.

Length about 0.5 mm.

Distribution.—This species was recorded by Brady from one *Challenger* station in the North Pacific, depth 2,300 fathoms, and by Bagg from *Albatross* station H4579 in 387 fathoms, off the Hawaiian Islands.

I have not found material which could be referred here. Bagg's specimens which I have examined are too poor for figuring. The figure given here is from Brady.

POLYMORPHINA LACTEA (Walker and Jacob), var. DIFFUSA Jones and Chapman.

Plate 41, fig. 8.

Polymorphina lactea, fistulose form, H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 560, pl. 73, fig. 14.

Polymorphina spp., var. *diffusa* JONES and CHAPMAN, Journ. Linn. Soc. London, vol. 25, 1896, p. 505, figs. 26–29.

Polymorphina lactea (WALKER and JACOB), var. *diffusa* CHAPMAN, Journ. Quekett Micr. Club, 1907, p. 131, pl. 10, fig. 1.

Description.—Early chambers similar to the typical *Polymorphina lactea*, but finally developing a "wild growth" of a fistulose form, usually spinose and irregular.

Distribution.—The specimen figured is from *Albatross* station D4900, Eastern Sea of Japan, 139 fathoms, bottom temperature 52.9° F. It has a much greater development of the fistulose chamber than either of the other two specimens to which reference is given above. The earlier portion, however, is similar to *Polymorphina lactea.*

POLYMORPHINA AMYGDALOIDES Reuss.

Plate 41, fig. 5.

Globulina amygdaloides REUSS, Zeitschr. d. deutsch. geol. Ges., vol. 3, 1851, p. 82, pl. 6, fig. 47.

Polymorphina amygdaloides REUSS, Sitz. Kais. Akad. Wiss. Wien, vol. 18, 1855, p. 250, pl. 8, fig. 84.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 561, pl. 71, fig. 13.—BURROWS and HOLLAND, Proc. Geol. Assoc., vol. 15, 1897, p. 46, pl. 2, fig. 18.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 261.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 9, pl. 2, figs. 12–14.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 148.

Polymorphina lactea WALKER and JACOB, var. *amygdaloides* H. B. BRADY, PARKER, and JONES, Trans. Linn Soc. London, vol. 27, 1870, p. 214, wood cuts.

Description.—Test oval, somewhat compressed, cross-section eliptical, chambers few, elongate, sutures only very slightly depressed; wall smooth.

Length 0.6 to 1 mm.

Distribution.—Bagg records the species from three *Albatross* stations in the vicinity of the Hawaiian Islands, D4017, 305 fathoms; D4174, 735–865 fathoms; and H4567, in 1,307 fathoms.

I have found no material to place in this species. The figures are drawn from the specimens recorded by Bagg.

POLYMORPHINA GIBBA d'Orbigny.

Plate 41, fig. 4.

"Polymorphina Subcordiformia vel Oviformia" SOLDANI, Testaceographia, vol. 1 to 2, 1791, p. 114, vol. 113, figs. *zz*, *C*, etc.

Polymorphia (*Globulina*) *gibba* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 226, No. 20; Modèles, No. 63.—EGGER, Neues Jahrb. für Min., 1857, p. 288, pl. 13, figs. 1–4.

Polymorphina gibba H. B. BRADY, PARKER, and JONES (part), Trans. Linn. Soc. London, vol. 27, 1870, p. 216, pl. 39, figs. 2*a–d*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 561, pl. 71, figs. 12*a*, *b*.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 486.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 10, pl. 2, figs. 15–17.—CHAPMAN, Journ. Quekett Micr. Club, 1907, p. 131.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 149.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 279.

Globulina gibba D'ORBIGNY, For. Foss. Vienne, 1846, p. 227, pl. 13, figs. 13, 14.

Description.—Test rotund, front view nearly circular, end view broadly oval; visible chambers few; broad sutures slightly excavated; wall smooth, aperture somewhat produced.

Length 0.75 to 1 mm.

Distribution.—Bagg records this species from one station only, *Albatross* H4430, rarely, in 1,544 fathoms, off the Hawaiian Islands. The specimen I have examined, and it is typical. I have a single specimen from *Albatross* D4807, in 44 fathoms, off Japan.

POLYMORPHINA ANGUSTA Egger.

Plate 39, fig. 6.

Polymorphina (*Globulina*) *angusta* Egger, Neues Jahrb. für Min., 1857, p. 290, pl. 13, figs. 13–15.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 563, pl. 72, figs. 1–3.

Description.—Test elongate, compressed, cylindrical, apical end acute and subacute, apertural end obtuse, chambers comparatively few, elongate, sutures but very slightly depressed; wall smooth, aperture finely radiate.

Length 0.6 to 0.8 mm.

Distribution.—Brady records this species from one *Challenger* station in the North Pacific, station 241, in 2,300 fathoms. Bagg also records it in another, Hawaiian Islands, *Albatross* D4017, in 305 fathoms. Bagg's specimen which I have examined seems more like a *Quinqueloculina* than a *Polymorphina*, but it is too poor to make out surely. I have had specimens from three *Nero* stations, 170, northwest of the Hawaiian Islands toward Midway Island, 1,990 fathoms; station 1300 in 1,088 fathoms, and 1301 in 1,529 fathoms, both south of Japan.

POLYMORPHINA LANCEOLATA Reuss.

Plate 40, fig. 2.

Polymorphina lanceolata Reuss, Zeitschr. d. deutsch. geol. Ges., vol. 3, 1851, p. 83, pl. 6, fig. 50; Sitz. kais. Akad. Wiss. Wien, vol. 62, 1870, p. 487, No. 12.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 564, pl. 72, figs. 5–6.

Polymorphina fusiformis H. B. Brady, Parker, and Jones (part), Trans. Linn. Soc. London, vol. 27, 1870, p. 219, pl. 39, figs. 5*b*, *c*.

Description.—Test elongate, compressed, cylindrical, fusiform, initial end rather acute, apertural end obtusely pointed; chambers several, smooth, elongate, tumid, sutures somewhat depressed, last formed chamber rather more inflated; wall smooth.

Length 1 to 1.25 mm.

Distribution.—This species has not previously been recorded for the North Pacific. Material referable here has been obtained at several *Nero* stations between Guam and Japan, depths between 1,529 and 2,119 fathoms. The species is not well distinguished from *Polymorphina rotundata*, differing especially in the more elongate form and less tapering outline.

POLYMORPHINA COMMUNIS d'Orbigny.

Plate 37, fig. 7.

Polymorphina (Guttulina) communis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, pl. 12, figs. 1–4; Modèles, No. 62.—Egger, Neues Jahrb., 1857, p. 288, pl. 13, figs. 16–18.

Polymorphina communis H. B. Brady, Parker, and Jones, Trans. Linn. Soc. London, vol. 27, 1870, pl. 39, p. 224, figs. 10*a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 568, pl. 72, fig. 19.—Burrows and Holland, Proc. Geol. Ass., vol. 15, 1897, p. 46, pl. 2, fig. 14.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 319, pl. 67, fig. 2.—Millett, Journ. Roy. Micr. Soc., 1903, p. 263.—Chapman, Journ. Quekett Micr. Club, 1907, p. 131.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 11.

Description.—Test ovate, somewhat elongate, initial end broadly rounded, apertural end somewhat obliquely pointed; chambers few, inflated, sutures excavated; wall smooth.

Length 0.75 to 1 mm.

Distribution.—This species is recorded by Flint from *Albatross* station 2842 in 72 fathoms off Unalaska. Bagg records it from the Hawaiian Islands, but I am inclined, after examination, to place his specimens under *Polymorphina sororia.* I have seen specimens from *Tuscarora* station 11, in 437 fathoms in the eastern Pacific, and *Albatross* H4856 in 898 fathoms in Bering Sea. This species has more or less tumid chambers and a rounded initial end but is variable.

POLYMORPHINA OVATA d'Orbigny.

Plate 30, fig. 2.

Polymorphina ovata d'Orbigny, For. Foss. Vienne, 1846, p. 233, pl. 13, figs. 1–3.—Reuss, Sitz. kön. Akad. Wien, vol. 55, 1867, p. 91.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 564, pl. 72, figs. 7, 8.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 54.

Description.—"The test of this species has an oval but somewhat inequilateral outline and the two faces are almost equally convex; the oral end is obtuse, the aboral acuminate. The segments are arranged with regularity in two alternating series, the last pair occupying two-thirds of the visible shell. The sutures are complinate and are marked by fine lines without external depressions." Description copied from Brady.

Distribution.—Goës records this species as rare from *Albatross* station 3407 in 885 fathoms. This specimen is here figured.

POLYMORPHINA OVATA d'Orbigny, fistulose form.

Plate 40, fig. 4.

A specimen with long branching last-formed chambers was found in material from the Gulf of Sidra. The early chambers seem to be allied to *Polymorphina ovata.* It is an exceptionally branching and extended form.

POLYMORPHINA OBLONGA d'Orbigny.

Plate 37, fig. 6.

Polymorphina oblonga d'Orbigny, For. Foss. Vienne, 1846, p. 232, pl. 12, figs. 29–31.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 569, pl. 73, figs. 2–4.—Chaster, First Rep. Southport, Soc. Nat. Sci., 1890–91 (1892), p. 64, pl. 1, fig. 13.—Egger, Abh. kön. bay. Acad. Wiss. München, Cl. ii, vol. 18, 1893, p. 309, pl. 11, figs. 9, 10, 24.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 319, pl. 67, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1903, p. 164.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 12, pl. 2, fig. 20.—Chapman, Journ. Quekett Micr. Club, 1907, p. 132; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 280.

Description.—"The test is more or less compressed, and has six to eight visible segments which are somewhat oblong and inflated in contour and separated by excavated sutures."

Brady records this species from the North Pacific down to 2,050 fathoms. The species is recorded by Bagg, but an examination of his specimens show it to be an *Uvigerina* with a phialine lip on the opposite end from which the aperture would be if the specimen were a *Polymorphina* of this species. The description and figure are from Brady.

POLYMORPHINA ROTUNDATA (Bornemann).

Plate 40, fig. 1.

Guttulina rotundata Bornemann, Zeitschr. d. deutsch. geol. Ges., vol. 7, 1855, p. 346, pl. 18, fig. 3.

Polymorphina rotundata Reuss, Sitz. Akad. Wiss. Wien, vol. 62, 1870, p. 487, No. 14.—von Schlicht, Foram. Pietzpuhl, 1870, pl. 26, figs. 13–15; pl. 28, figs. 1–5; pl. 30, figs. 33–40.—H. B. Brady, Parker, and Jones, Trans. Linn. Soc. London, vol. 27, 1870, p. 234, p. 40, fig. 19*a–e* and wood cuts.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 570, pl. 73, figs. 5–8.

Description.—Test broadest at the apertural end, tapering rapidly toward the initial end; chambers several, earlier ones with slightly depressed sutures, later ones inflated, sutures deeper; aperture produced, radiate; wall smooth or with a slight indication of striæ.

Length 1.50 to 2 mm.

Distribution.—Brady records this species from *Challenger* station 224 in 1,850 fathoms. I have had material from *Nero* station 1287 in 1,606 fathoms between Guam and Japan.

POLYMORPHINA SORORIA Reuss.

Plate 30, fig. 3.

Polymorphina (*Guttulina*) *sororia* Reuss, Bull. Acad. Roy. Belg., ser. 3, vol. 15, 1863, p. 151, pl. 2, figs. 25–29.

Polymorphina sororia H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 562, pl. 71, figs. 15, 16.—Chapman, Journ. Roy. Micr. Soc., 1896, p. 12, pl. 2, figs. 11, 12.—Millett, Journ. Roy. Micr. Soc., 1903, p. 265.

Description.—Test similar to *Polymorphina communis*, but the sutures less defined; chambers less inflated, apical end less rounded, whole test more fusiform.

Length 0.6 to 0.8 mm.

Distribution.—This species is recorded by Picaglia from long. 109° 58′ W.; lat. 0° 47′ N. in 4,670 meters.

Bagg's specimens referred by him to *Polymorphina communis* seem more properly to be placed here. His specimens are figured. They are from *Albatross* station H4585 in 689 fathoms near the Hawaiian Islands.

POLYMORPHINA COMPRESSA d'Orbigny.

Plate 40, fig. 3.

Polymorpha "Subovalia" SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, p. 114, pl. 114, fig. F, I; pl. 115, fig. N; pl. 116, figs. V, X, etc.

Polymorphina compressa D'ORBIGNY, For. Foss. Vienne, 1846, p. 233, pl. 12, figs. 32–34.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc. London, p. 227, pl. 40, figs. 12*a–f*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 565, pl. 72, figs. 9–11.—MARIANI, Boll. Soc. Geol. Italia, vol. 7, 1888, p. 288, pl. 10, fig. 13.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 487.—EGGER, Abh. kön. bay. Acad. Wiss. München, Cl. II, vol. 18, 1893, p. 309, pl. 9, figs. 11–13.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 58, pl. 10, figs. 539–553.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 319, pl. 67, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 262.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 51, No. 9, 1907, p. 13, pl. 3, figs. 1–6, 12, 13 [?].—BAGG, U. S. Nat. Mus., vol. 34, 1908, p. 149.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 280.

Description.—Test usually oblong, strongly compressed, chambers numerous, elongate, but often as broad as long in surface view except the last, in an alternating biserial arrangement, sutures somewhat excavated, surface somewhat smooth, but occasionally with traces of striæ near the initial end; aperture strongly radiate, often on a protuberant portion of chamber.

Length up to 3.15 mm.

Distribution.—Brady records this species from the North Pacific without station. Bagg records it from three stations off the Hawaiian Islands, D4017, 305 fathoms, H4430 in 1,544 fathoms, and H4694 in 865 fathoms. Of the two specimens of the Bagg material in Washington which I have examined, the specimen from D4017 is definitely a *Quinqueloculina* and that from H4694 too broken to determine.

Excellent specimens of this species were obtained from material dredged at *Albatross* station H4878 in 84 fathoms and D4825 in 120 fathoms, adjacent stations off the coast of Japan.

This seems to be a more clearly defined species than most of the others of the genus.

POLYMORPHINA ELEGANTISSIMA Parker and Jones.

Plate 38, fig. 1.

Polymorphina elegantissima PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 438.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 231, pl. 40, fig. 15*a–c*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 566, pl. 72, figs. 12–15.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 319, pl. 67, fig. 4.—MILLETT, Journ. Roy. Micr. Soc., 1893, p. 263.—CHAPMAN, Journ. Quekett Micr. Club, 1907, p. 132, pl. 10, fig. 3; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 280.

Description.—Test ovate, initial end broad and rounded, apical end tapering, bluntly pointed, end view often subtriangular; chambers few but unequally biserial; wall smooth, sutures not depressed but of a darker color; aperture radiate, prolonged.

Length up to 1 mm.

Distribution.—This is evidently a tropical or subtropical species of comparatively shallow waters. It has been obtained in the Australian and the East Indian region. In the North Pacific Brady records it from Hongkong Harbor, 7 fathoms. I have had specimens collected from the Inland Sea of Japan, depth not given.

The arrangement of chambers in this species is peculiar for the genus, the biserial arrangement being oblique, so that the last-formed chamber on one side of the test covers all previously added chambers of that side and on the other side leaves the other set exposed. In this way there are a number of chambers visible from either side of the test.

POLYMORPHINA LONGICOLLIS H. B. Brady.

Plate 41, figs. 1–3.

Polymorphina lanceolata REUSS (part), Sitz. kön. Akad. Wiss. Wien, vol. 62, 1870, p. 487, No. 12.—VON SCHLICHT, Foram. Pietzpuhl, 1870, pl. 31, figs. 25–28, etc.

Polymorphina longicollis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 64; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 572, pl. 73, figs. 18, 19.

Description.—Test fusiform; chambers few, smooth inflated, especially the last-formed one, sutures but slightly excavated; surface more or less hispid, the last-formed chamber spinose; aperture with an elongate neck, often irregular, sometimes with a radiate lip.

Length about 0.75 mm.

Distribution.—This species has not previously been recorded for the North Pacific. I have had material from *Nero* station 2061 in 1,670 fathoms off the Hawaiian Islands and *Nero* station 1319 in 2,167 fathoms between Guam and Japan.

This seems to be essentially a deep-water species, the stations given by Brady averaging about this same depth.

A fistulose form which is hispid throughout and evidently belongs to this species was found at *Nero* station 1063, in 1,884 fathoms, in the line of soundings between Guam and Japan. It is here figured.

POLYMORPHINA REGINA H. B. Brady, Parker, and Jones.

Plate 41, figs. 6, 7.

Polymorphina regina H. B. Brady, Parker, and Jones, Trans. Linn. Soc. London, vol. 27, 1870, p. 241, pl. 41, figs. 32*a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 571, pl. 73, figs. 11-13.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 310, pl. 9, figs. 45, 50, 51.—Millett, Journ. Roy. Micr. Soc., 1903, p. 265.—Chapman, Journ. Quekett Micr. Club, 1907, p. 132, pl. 10, fig. 4.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 149.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 281.

Description.—Test fusiform; chambers several, inflated, with deep sutures; wall ornamented with elongate, coarse costæ, usually not broken on the individual chambers; aperture radiate, produced.

Length 0.60 to 1 mm.

Distribution.—The only records for this species in the North Pacific are from the region of the Hawaiian Islands. Brady found it in the *Challenger* material from off Honolula in 40 fathoms. Bagg records it from *Albatross* station H4694 in 865 fathoms as rare, and I have found it in material from *Albatross* station H2922 in 268 fathoms. It seems to be a tropical species of comparatively shallow water.

Subfamily 4. UVIGERININÆ.

Test composed of several chambers, typically spirally arranged, especially in the earlier portion, later chambers often becoming loosely arranged, or even uniserial; wall smooth or variously ornamented; aperture typically consisting of a neck with a definite phialine lip.

In *Uvigerina* the spirally arranged chambers are typical, old age characters appearing in the loss of ornamentation or in the tendency to become loosely spiral as in *U. interrupta*. In *Siphogenerina* the early chambers are spiral or biserial, especially well developed in the microspheric forms, and the later development is uniserial.

Genus UVIGERINA d'Orbigny, 1826.

Uvigerina d'Orbigny (type, *U. pygmæa* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 268.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 573.

Description.—Test elongate, spiral, consisting of numerous chambers, usually arranged triserially, occasionally in later growth with fewer than three chambers in each volution; wall calcareous, perforate, hyaline, smooth or ornamented with spines or costæ or modifications of them; aperture with usually a tubular neck at the end of which is a phialine lip.

The genus *Uvigerina* is one of the most clearly distinguished of any of the genera of the Foraminifera. Its triserial arrangement of chambers with a tubular aperture and phialine lip will at once serve to distinguish it. In some of the species in the last-formed chambers there is a tendency to reduce the number of chambers in a volution to two, or even to become almost uniserial as in *Uvigerina interrupta* H. B. Brady. The surface ornamentation presents a considerable range from smooth and unornamented as in *U. canariensis* d'Orbigny, through the finely striate forms to ones with heavy costæ, and these may be broken into spines or the whole test may be spinose, as in *U. asperula* Czjzek and *U. interrupta* H. B. Brady. One of the most interesting forms of ornamentation in the genus is the secondary development of spines in *U. aculeata* d'Orbigny, developed in the later chambers first, but progressively extending backward and finally in some cases covering the entire test.

The genus *Uvigerina* is known from the Eocene through the later formations of the Tertiary to the present. Some of the species seem to have a limited distribution, both geographically and bathymetrically, but others, as *U. pygmæa* d'Orbigny, have a much wider range geographically and are found to considerable depths.

UVIGERINA CANARIENSIS d'Orbigny.

Plate 42, fig. 6.

"Testæ pineiforme sminusculæ" SOLDANI, Testaceographia, vol. 2, 1798, p. 18, pl. 4, figs. E, F, G, H.

Uvigerina nodosa, var. B D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, No. 3.

Uvigerina canariensis D'ORBIGNY, Foram. Canaries, 1839, p. 138, pl. 1, figs. 25–27.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 573, pl. 74, figs. 1–3.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Survey Minnesota for 1884 (1885), p. 171, pl. 4, fig. 37; Geol. Nat. Hist. Survey Minnesota, vol. 3, 1893, p. 39, pl. D, fig. 9.—EGGER, Abh. kön. bay. Akad. Wiss. München, cl. II, vol. 18, 1893, p. 311, pl. 9, fig. 43.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 52, pl. 9, figs. 489–492.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 266, pl. 5, fig. 7.—SIDEBOTTOM, Mem. Manchester Lit. and Philos. Soc., vol. 52, 1908, No. 13, p. 1, pl. 1, figs. 1, 2.—CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1910, p. 414.

Uvigerina urnula D'ORBIGNY, Foram. Foss. Bass. Test. Vienne, 1846, p. 189, pl. 11, figs. 21, 22.

Uvigerina irregularis H. B. BRADY, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865, p. 100, pl. 12, fig. 5.

Description.—Test elongate, made up of numerous chambers, spirally arranged, three chambers making up each whorl, chambers inflated, rotund, distinctly separated externally by rather deep sutures; wall smooth, occasionally the early chambers showing traces of costæ or spines; aperture usually with a tubular neck and broad phialine lip; color grayish-white.

Length 1 mm. or somewhat more.

Distribution.—From the material examined the species seems to be generally distributed in the North Pacific, for the most part in comparatively deep water. It has occurred in Bering Sea, in material from the stomachs of holothurians dredged at *Albatross* station D3603 at 1,771 fathoms and from both the eastern and western sides of the North Pacific in depths from 1,597 to 2,112 fathoms. From the region of the Hawaiian Islands Bagg records it from three *Albatross* stations, D4000, D4025, and H4571 in from 104 to 384 fathoms. The least depth at which any of the material of this species which I have examined was dredged was at *Tuscarora* station 11 in 437 fathoms, about midway between the Hawaiian Islands and the California coast. Brady did not record the species from the North Pacific.

From the material at hand and a study of the published figures referred to this species it is evident that there is a considerable difference in the material referred here. Some of the figured specimens are fusiform, decidedly tapering at either end and with a long, drawn out tubular neck, others as in the figured specimen are much the largest near the apertural end. All are uniform in having the surface of the adult chambers smooth, but the early chambers are either smooth as in the type figure, or slightly costate (*U. urnula* d'Orbigny) or slightly spinose as in the figured specimen. A larger series should throw some light on the actual distribution of the various forms now included under this specific name.

UVIGERINA CANARIENSIS d'Orbigny, subspecies STRIATA Bagg.

Uvigerina canariensis D'ORBIGNY, subspecies *striata* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 151, pl. 5, fig. 2.

Description.—"* * * A form which has definite striations extending in groups clear and well defined, though not closely set down, and over the last chamber as well as over the earlier segments as in *Uvigerina pygmæa.* The inflation of the segments is marked and the septa are depressed."

Distribution.—Bagg described this subspecies from material dredged off the Hawaiian Islands at *Albatross* station H4566 in 572 fathoms.

I have examined the type-specimen, but in the absence of sufficient material am inclined to leave it here until more may be available. The description is copied from the original. A single specimen very similar to that figured by Bagg was found in globigerina ooze at *Nero* station 172 in 2,086 fathoms near the Midway Islands.

UVIGERINA SELSEYENSIS Heron-Allen and Earland.

Plate 42, fig. 5.

Uvigerina selseyensis HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1909, p. 437, pl. 18, figs. 1–3.

Description.—Test subovate, broadest toward the apertural end, chambers numerous, early ones rotund, triserially arranged, later ones more or less trihedral, more loosely arranged; the outer lower margins somewhat angular and projecting, wall smooth, aperture with a very short broad neck with a narrow phialine lip.

Length about 0.35 mm.

Distribution.—This species, described as a European fossil, seems to occur in the North Pacific, specimens from *Albatross* station H2923 in 392 fathoms being very similar to *U. selseyensis.* The figure does not show the angular character of the periphery of the chambers, but this occurs and makes the resemblance much more striking, and the comparison made by the authors that the species resembles both *U. angulosa* and *U. porrecta* is well sustained.

UVIGERINA PROBOSCIDEA Schwager.

Plate 42, fig. 2.

Uvigerina proboscidea Schwager, *Novara* Exped., Geol. Theil, 2, 1866, p. 250, pl. 7, fig. 96.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 312, pl. 9, fig. 53.

Description.—Test ovate, tapering somewhat at either end, chambers inflated, but closely set with sutures nearly flush, surface slightly hispid with very fine aculei, aperture with a tapering tubular neck with the greatest diameter near the base and a slightly phialine lip.

Length about 0.5 mm.

Distribution.—Not previously recorded from the North Pacific. Described from the Pliocene of Kar Nicobar and recorded by Egger from *Gazelle* station 90 off Western Australia. Specimens which seem to be this species were found at *Nero* station 1464 in 891 fathoms off Guam.

Although Brady places this species as a synonym of *U. canariensis,* it seems that it belongs rather with the hirsute group of the genus. Our specimens are very similar to the drawing of the type.

UVIGERINA STRIATA d'Orbigny.

Plate 43, fig. 5.

Uvigerina striata d'Orbigny, Voyage Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 53, pl. 7, fig. 16.

Uvigerina tenuistriata Bagg (part) (not *U. tenuistriata* Reuss), Proc. U. S. Nat. Mus., vol. 34, 1908, p. 151.

Description.—Test elongate, fusiform, tapering rather abruptly toward either end, chambers numerous, three in each whorl, somewhat inflated and separated by fairly deep sutures, wall with fine longitudinal costæ somewhat interrupted; somewhat angul in end view; aperture with a short tapering tubular neck without a definite phialine lip.

Length 0.3 to 0.6 mm.

Distribution.—Specimens referred to *U. tenuistriata* Reuss by Bagg from *Albatross* station H4696 in 367 fathoms off the Hawaiian Islands seem to fit excellently the figure and description of *U. striata* given by d'Orbigny. The finely costate tapering test and the characters of the apertural portion are very different from the more common material usually referred by authors to *U. pygmæa.*

UVIGERINA TENUISTRIATA Reuss.

Plate 42, fig. 4.

Uvigerina tenuistriata REUSS, Sitz. kais. Akad. Wiss. Wien, vol. 52, 1870, p. 485.—VON SCHLICHT, Foram. Pietzpuhl, 1870, pl. 22, figs. 34–36.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 574, pl. 74, figs. 4–7.—EGGER, Abh. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 315, pl. 9, figs. 44, 52.

Description.—Test elongate, subcylindrical, tapering at the apical end, composed of numerous rounded chambers with distinct sutures; wall with numerous fine raised longitudinal costæ, except the distal portion of the last-formed chamber, or in full-grown specimens more than the last chamber, with roughened or even nearly smooth walls; aperture with a short comparatively thick tubular neck with usually a distinct phialine lip.

Length about 1 mm.

Distribution.—Recorded by Brady in the North Pacific in 95 fathoms off the Philippines. I have not seen material definitely referable to this species from the North Pacific. Bagg's material which I have examined seems to belong to *U. striata,* although recorded by him under the name *tenuistriata.*

UVIGERINA STRIATULA, new species.

Plate 44, fig. 3.

Description.—Test elongate, fusiform, tapering gradually from the middle toward either end; composed of numerous inflated chambers, those last formed considerably drawn out, wall usually thin and translucent, finely and distinctly striated; aperture with a tubular neck and phialine lip.

Length about 0.5 to 0.7 mm.

Distribution.—Type-specimen, Cat. No. 8551, U.S.N.M., from *Nero* Station 1310 in 518 fathoms, globigerina ooze, near the Bonin Islands. It also occurred from the same region at *Nero* Station 1306 in 1,208 fathoms, also in globigerina ooze.

In its extreme modification this species has a general resemblance to *U. interrupta* H. B. Brady, but most of the specimens examined were less drawn out than is usual in that species.

UVIGERINA PYGMÆA d'Orbigny.

Plate 42, fig. 1; plate 44, fig. 5.

"Polymorpha Pineiformia" SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, pl. 130, figs. *ss*, *tt*.

Uvigerina pigmea D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, pl. 12, figs. 8, 9; Modelès, 1826, No. 67.

Uvigerina pygmæa D'ORBIGNY, For. Foss. Bass. Test. Vienne, 1846, p. 190, pl. 11, figs. 25, 26.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 297, pl. 11, figs. 41–43.—WILLIAMSON, Rec. Brit. Foram., 1858, p. 66, pl. 5, figs. 138, 139.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 54.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 363, pl. 17, figs. 65*a*, *b*; pl. 13, fig. 54.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 171, pl. 11, fig. 109.—SCHWAGER, Boll. R. Com. Geol. Ital., vol. 8, 1877, p. 25, pl., fig. 34.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 59, pl. 4, figs. 68–70.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 575, pl. 74, figs. 11–14.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 224, pl. 45, figs. 1, 2.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 487.—EGGER, Abh. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 314, pl. 9, fig. 42.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 51, pl. 9, figs. 496–501.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 35.—GOËS, Bull. Mus. Comp. Zoöl., vol. 26, 1896, p. 50.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 320, pl. 68, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 269.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 99.—SIDEBOTTOM, Mem. Manchester Lit. and Philos. Soc., vol. 54, 1910, No. 16, p. 23.—CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1910, p. 414.

Uvigerina bifurcata D'ORBIGNY, Foram. Voyage Amér. Mérid., 1839, p. 53, pl. 7, fig. 17.

Uvigerina semiornata D'ORBIGNY, For. Foss. Bass. Tert. Vienne, 1846, p. 189, pl. 11, figs. 23, 24.

Description.—Test broadly ovate to subcylindrical, chambers numerous, inflated, with distinct sutures; wall with large, well-developed costæ, placed longitudinally, apical end rather bluntly rounded, the earliest chambers visible with costæ plainly developed; aperture with a short, stout tubular neck and a distinct phialine lip; color of the test white to a light brown.

Length 0.5 to 1 mm.

Distribution.—This species is one of the most widely distributed of the family, being found in all the ocean basins. In the North Pacific, Brady speaks of it as rare, but this was due to simple lack of material, for I found it widely distributed in all parts running northward into Bering Sea, where it is very common at several stations. As a rule it seems to be most abundant in cold waters and at the north in shallow water, while southward toward the Equator it seems to occur most frequently at a considerable depth where the water is again cold. Brady recorded the species from the Hawaiian Islands and Bagg records it from the same region at five *Albatross* stations. Goës records it from two stations off the west coast of America, one at the entrance of the Gulf of California, the other southwest of Panama. In the material I have examined it has occurred frequently in the *Albatross, Nero,* and *Tuscarora* dredgings.

D'Orbigny's original figures of this species show a fusiform tapering test, in which the last-formed chambers lack the characteristic costæ and in which the tubular neck is long. Later in his Vienna Basin monograph he uses the same name for a test of different form, still fusiform but with a much shorter and stouter neck. In recent material, however, in almost all cases the later-formed chambers are broad and the test is much broader toward the apical end. The figures given by Brady, Parker, and Jones[1] of specimens from the Abrolhos Bank and by Flint[2] show the typical form so abundant in the cooler waters of recent seas.

UVIGERINA SCHWAGERI H. B. Brady.

Plate 37, figs. 3, 4.

Uvigerina schwageri H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 575, pl. 74, figs. 8–10.—Chapman, Proc. Zool. Soc. London, 1895, p. 35.

Description.—Test elongate, subovate, tapering to a blunt point at the aboral end; segments numerous, only slightly inflated externally; surface ornamented by a few ill-defined, partial costæ; color pure white.

Length 1.6 mm.

Distribution.—Brady records this species from 95 fathoms off the Philippines in the North Pacific as well as from off the Fiji Islands and Torres Strait. Chapman records it from the Arabian Sea. Outside of the Philippine region I have failed to find this species in the North Pacific.

The figures and description are from Brady.

UVIGERINA BRUNNENSIS Karrer.

Plate 43, fig. 2.

Uvigerina brunnensis Karrer, Abh. k. geol. Reichs., vol. 9, 1877, p. 385, pl. 16*b*, fig. 49.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 577, pl. 75, figs. 4, 5.—Egger, Abh. kön. bay. Akad. Wiss. München, 1893, p. 312, pl. 9, figs. 60, 61.—Chapman, Proc. Zool. Soc. London, 1895, p. 36.

Description.—Test elongate, composed of numerous inflated chambers, wall with longitudinal costæ for the most part breaking up into rows of spinose projections longitudinally placed; aperture with a short stout neck with a broad phialine lip.

Length about 0.75 mm.

Distribution.—This species has not hitherto been recorded from the North Pacific. Brady's stations were off Christmas Harbor, Kerguelen Island, 120 fathoms, and off the western shore of Patagonia, 245 fathoms. Egger also recorded it at two stations off Kerguelen at similar depths. Chapman records it from the Arabian Sea. I have had the species from numerous stations, only one, *Albatross* station H2764, 122 fathoms near the Hawaiian Islands, being less than a thousand fathoms. It has occurred at numerous *Nero* stations mostly between Guam and Yokohama in 1,415 to 2,135 fathoms.

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[1] Trans. Zool. Soc. London, vol. 12, 1888, pl. 45, figs. 1, 2.

[2] Ann. Rep. U. S. Nat. Mus., 1897 (1899), pl. 68, fig. 2.

Although the recent material does not agree very closely with Karrer's original description it may be left under that name.

UVIGERINA ANGULOSA Williamson.

Plate 44, fig. 4.

Uvigerina angulosa Williamson, Rec. Foram. Great Britain, 1858, p. 67, pl. 5, fig. 140.—Seguenza, Atti Accad. Lincei., ser. 3, vol. 6, 1879, pp. 226, 307.—Bütschli, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 200, pl. 7, fig. 31.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 576, pl. 74, figs. 15–18.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 347.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 487.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 314, pl. 9, figs. 40, 46, 47.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 51, pl. 9, figs. 502–509.—Jones, Pal. Soc., 1895, p. 277, pl. 7, fig. 26.—Chapman, Proc. Zool. Soc., London, 1895, p. 35.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 320, pl. 68, fig. 3.—Liebus, Neues Jahrb. für Min., vol. 1, 1901, p. 120, pl. 5, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1903, p. 269.—Chapman, Journ. Quekett Micr. Club., ser. 2, vol. 10, 1907, p. 132, pl. 10, fig. 5.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, pt. 3, No. 13, 1908, p. 1, pl. 1, fig. 4.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, new series, pt. 2, 1910, p. 281.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, pt. 3, No. 16, 1910, p. 23.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 414.

Uvigerina pygmaea, var. *angulosa* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 364, pl. 13, fig. 58; pl. 17, fig. 66.

Description.—Test elongate tapering toward either end, composed of numerous chambers, three making each whorl, chambers compressed at two sides making a decided angle in the middle and making up a trifacial test, triangular in end view and section; wall more or less costate, usually the costæ numerous and distinct; aperture with a short tubular neck and with a phialine lip usually more developed on the outer side.

Length 0.5 to 0.85 mm.

Distribution.—In general this species appears to be widely distributed. Brady records it from three North Pacific stations in from 50 to 500 fathoms. Flint records it from Panama Bay in 51 fathoms. Bagg records it from numerous stations about the Hawaiian Islands in 104 to 1,342 fathoms. I have had typical material from four *Albatross* stations, H2922 in 268 fathoms near the Hawaiian Islands and D4813, D4818, and D4857 in 200, 225, and 324 fathoms, respectively, off the coast of Japan.

The characters of this species are very distinctive and it is not easily mistaken.

UVIGERINA ANGULOSA Williamson, var. SPINIPES H. B. Brady.

Plate 43, fig. 3.

Uvigerina spinipes H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 64.
Uvigerina angulosa WILLIAMSON, var. *spinipes* H. B. BRADY, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 577, pl. 74, figs. 19, 20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 315, pl. 9, fig. 59.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 200.

Description.—Test elongate, tapering toward either end, chambers more or less triangular in cross section, early chambers with longitudinal costæ often prolonged into spinose projections at the apical end; later chambers with smooth walls and more loosely arranged; aperture with a tubular neck gradually merging into the outline of the chamber at the proximal end and with a definite phialine lip at the outer end.

Length about 0.75 mm.

Distribution.—This variety has not been recorded from the North Pacific. Brady recorded it from off Tristan d'Acunha, Egger from two stations off New Amsterdam and West Australia, and Chapman from the Arabian Sea.

The only North Pacific material I have seen is from *Nero* station 1306, in 1,208 fathoms between Yokohama and Guam. The figured specimen is from this station.

Brady described this as a distinct species and it certainly has but little in common with *U. angulosa* Williamson. With the exception of one of the stations recorded by Chapman and one by Egger, it has not occurred in company with *U. angulosa,* but as these are two from only five stations the percentage is rather large. The spinose condition of the early chambers is also different from what is usually seen in *U. angulosa.*

UVIGERINA PORRECTA H. B. Brady.

Plate 44, fig. 2.

Uvigerina porrecta H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 60, pl. 8, figs. 15, 16; Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 577, pl. 74, figs. 21–23.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 315, pl. 9, figs. 51, 63.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 414.

Description.—Test much elongated, early chambers in a close spiral, later ones drawn out and considerably separated from one another; chambers, especially the later ones, concave below, the peripheral edge angular and projecting; upper surface of the chambers convex and ornamented by coarse longitudinal costæ which project at the peripheral edge, making it serrate; aperture with an elongated tubular neck, the lip not well developed.

Length about 0.5 mm.

Distribution.—From the known records this species seems to be confined to the region of coral reefs, although it may occur at considerable depths, as shown by Chapman, who records it at 2,400 fathoms off Funafuti. Such records as have already been noted in regard to other coral reef species in this paper may be due to the carrying out of such species into deep water through the action of currents. Brady records this species from north of New Guinea in 1,850 fathoms as the only North Pacific station. I have not seen it from the region of the coral reefs of the Hawaiian Islands nor does Bagg record it from this region. I have found it, however, in material from several *Nero* stations near Guam in 859 to 1,503 fathoms. This material is typical.

There is a considerable variation in the costæ, which in some cases, as shown in figure 2, are only developed on the periphery of the chambers.

UVIGERINA ACULEATA d'Orbigny.

Plate 43, fig. 4.

Urigerina aculeata D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 191, pl. 11, figs. 27, 28.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 578, pl. 75, figs. 1, 2.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 487.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 311, pl. 9, figs. 48, 49.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 35.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 50.—FORNASINI, Boll. Soc. Geol. Ital., vol. 25, 1907, p. 348, pl. 4, fig. 1.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 414.

Description.—Test elongate, tapering; chambers numerous, inflated, sutures distinct, even under the ornamentation which in the early chambers is often made up of longitudinal costæ, the later chambers or all in some cases covered with a spinose development, having the appearance in certain specimens of a secondary shell layer, the spines stout, initial end of the test acute, usually with a spine; aperture with a short neck and flaring phialine lip.

Length up to 1.5 mm.

Distribution.—This species has been recorded from the North Pacific by Goës, from the west coast of America in 759 to 1,218 fathoms. In the mounted set returned to the United States National Museum by Goës there is but a single specimen of typical *U. aculeata*, the others being *U. pygmæa* and *U. asperula.* In the material which I have examined the typical form of the species shown in the figures has occurred but once, *Albatross* D4957, off Japan, in 437 fathoms, bottom temperature 39.8° F. At *Nero* station 1154, 1,602 fathoms, a specimen was dredged showing this spinose character well developed on the last formed chamber only. This species seems to be more common in the South Pacific.

UVIGERINA ASPERULA Czjzek.

Plate 43, fig. 1.

Uvigerina asperula Czjzek, Haidinger's Nat. Abh., 2, 1848, p. 146, pl. 13, figs. 14, 15.—Reuss, Sitz. kais. Akad. Wiss., Wien, vol. 55, Abth. 1, 1867, p. 93, pl. 4, figs. 6*a*, *b*, 7, 8, 9.—Terrigi, Atti Accad. Port. Nuovi Lincei, vol. 35, 1883, p. 185, pl. 2, fig. 26.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 578, pl. 75, figs. 6–8.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 755, pl. 16, fig. 7.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 225, pl. 45, figs. 4, 5.—Terrigi, Mem. Com. Geol. Italia, vol. 4, 1891, p. 100, pl. 3, fig. 25.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 487.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol, 18, 1893, p. 312, pl. 9, fig. 41.—Chapman, Proc. Zool. Soc. London, 1895, p. 35.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 320, pl. 68, fig. 4.—Millett, Journ. Roy. Micr. Soc., 1903, p. 267.—Chapman, Trans. New Zealand Inst., vol. 38, 1906, p. 99; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 415.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 150.

Description.—Test elongate-ovate, chambers somewhat inflated, sutures distinct but not deep; surface ornamented by a hispid or spinose exterior of much variableness in different specimens, the fine spines either in indefinite longitudinal rows or scattered without a definite arrangement; initial end bluntly rounded or with a distinct stout spine, aperture with a definite tubular neck with a well developed phialine lip.

Length 0.6 to 0.8 mm.

Distribution.—From the material examined this seems to be one of the most common species of the genus, having been dredged at many stations in various parts of the North Pacific, from 323 to 1,758 fathoms. It was recorded from between 20 and 40 stations well scattered over the area. The bottom temperature where recorded is in almost all cases between 35° and 36° F.

Brady records this species from three stations in the North Pacific in 345 to 2,300 fathoms, and Bagg records it from 13 *Albatross* stations off the Hawaiian Islands in 275 to 1,544 fathoms.

There is certainly a very considerable difference in the shape and ornamentation of the various forms assigned to this species. Even in the material examined it appears that various modifications can be segregated, and with sufficient material from other areas it would not be difficult to establish definite groups which have in general a hispid ornamentation.

The specimen figured is one of medium coarseness as far as the ornamentation is concerned.

UVIGERINA AMPULLACEA H. B. Brady.

Plate 42, fig. 3.

Uvigerina asperula Czjzek, var. *ampullacea* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 579, pl. 75, figs. 10, 11.—Chapman, Proc. Zool. Soc. London, 1895, p. 35.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 320, pl. 68, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1903, p. 267.—Bagg, Proc, U. S. Nat. Mus., vol. 34, 1908, p. 150.—Chapman, Journ. Linn. Soc., Zoology' vol. 30, 1910, p. 415.

Uvigerina ampullacea Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 313, pl. 9, fig. 37.

Uvigerina auberiana Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 52, pl. 9, figs. 494, 495.

Description.—Test composed in the early portion of a more or less compact spiral of chambers followed by two or more chambers uniserially arranged; surface finely hispid, with pointed aculei; aperture with an elongate neck and narrow rimmed phialine neck.

Length about 1 mm.

Distribution.—From the material examined this species is much less common in the North Pacific than *U. asperula*. It has occurred at numerous stations, mainly in the western Pacific and about the Hawaiian Islands. The shallowest station is *Nero* station, 2034, in 175 fathoms, near the Hawaiian Islands, and the deepest is *Nero* station 187, in 2,473 fathoms. Most of the stations had depths of less than 1,500 fathoms. The only stations from which the bottom temperatures are recorded are 35° and 38° F. Bagg records this species from several *Albatross* stations off the Hawaiian Islands in 384 to 1,342 fathoms.

The distribution of *U. ampullacea* and *U. asperula* is not identical in the material examined and the decidedly senescent character of uniserial arrangement of the chambers after the compact growth at the start make it seem that this form is worthy of specific rank.

UVIGERINA AUBERIANA d'Orbigny.

Plate 37, fig. 5.

Uvigerina auberiana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 106, pl. 2, figs. 23, 24.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 60, pl. 4, fig. 75; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 50.

Uvigerina asperula Czjzek, var. *auberiana* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 579, pl. 75, fig. 9.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 150.

Description.—Test ovate, chambers numerous. The later ones arranged biserially; surface covered with short spines; aperture with a short lip and phialine lip.

Length about 1 mm.

Distribution.—Bagg records this species from several *Albatross* stations in the vicinity of the Hawaiian Islands, in 384 to 1,307 fathoms. I have not found North Pacific material which seemed to me definite enough to assign to this species.

D'Orbigny's figure shows a coarsely spinose test with a shape somewhat different from that given by Brady and which is reproduced here.

UVIGERINA AUBERIANA d'Orbigny, forma LÆVIS Goës.

Uvigerina auberiana Goës (part), Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 60, pl. 4, figs. 71–74.

Uvigerina auberiana d'Orbigny, forma *lævis* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 51.

Description.—"Our form comes very near to *U. farinosa* Hantken,[1] and is in all respects but for its smooth surface of similar build as the type, the strong relationship of which it shows, even by its earliest segments being provided with a few short spines or warts."

Length about 0.50 to 1 mm.

Distribution.—Given by Goës as found in the Eastern Pacific in 600 to 1,201 fathoms.

The above description is copied from Goës. No figure was given.

UVIGERINA INTERRUPTA H. B. Brady.

Plate 44, fig. 1.

Uvigerina interrupta H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 60, pl. 8, figs. 17, 18; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 580, pl. 75, figs. 12–14.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 313, pl. 9, fig. 58.—Chapman, Proc. Zool. Soc. London, 1895, p. 34.—Millett, Journ. Roy. Micr. Soc., 1903, p. 268.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 151.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 415.

Description.—Test slender, elongate, loosely spiral, chambers inflated, earlier ones in a more or less compact spire, later ones in an interrupted irregularly spiral series; surface with fine spines, giving a hispid character to the whole test; aperture with an elongated tubular neck and a phialine lip at its termination.

Length about 0.5 mm.

Distribution.—In the North Pacific the only records for this species are those given by Bagg, *Albatross* stations H4430, H4440, and H4508, in 1,544, 1,259, and 495 fathoms, respectively. In the material I have examined it has occurred most commonly off Guam and in the region between Guam and southern Japan, about the Hawaiian Islands, and off the Galapagos. The last were much smoother than the usual form. In depth the stations range from

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[1] For. Clavul. Száboi Sch., 1875, Separ., pl. 7, fig. 6.

437 to 1,505 fathoms. In temperature there is data but for three stations, 437 fathoms off Japan, 39.8° F.; 1,505 fathoms also off Japan, 35.7° F.; and 1,379 fathoms off the Galapagos, 36.4° F. In general, this species seems to have a tropical distribution running up to southern Japan.

Genus SIPHOGENERINA Schlumberger, 1883.

Sagrina PARKER and JONES (not *Sagrina* d'Orbigny), Philos. Trans., vol. 155, 1865, p. 363.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 580.

Dimorphina SCHWAGER (not *Dimorphina* d'Orbigny), *Novara* Exped., Geol. Theil., vol. 2, 1866, p. 251.

Siphogenerina SCHLUMBERGER [type, *S. raphanus* (Parker and Jones), *Uvigerina* (*Sagrina*) *raphanus* Parker and Jones], Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 117.

Description.—Test elongate, composed at least in the microspheric form of a series of chambers arranged tri- or biserially, followed by a later uniserial development; walls hyaline and perforate, aperture in the uniserial portion central and terminal, usually with an elongated neck and flaring lip; interior of the chamber with a tubular connection running from the base of the apertural neck to the lip of the aperture below; wall smooth or ornamented by costæ, pits, etc.

This genus is evidently closely related to *Uvigerina*, but seems to be distinct in its uniserial development, which in *Siphogenerina* becomes the major portion. In the megalospheric form the uniserial condition is taken on much earlier than in the microspheric form.

Both genera, *Sagrina* and *Dimorphina*, as used by d'Orbigny, undoubtedly belong to the Textulariidæ, and are not available for use here even as amended by Parker and Jones. Therefore the generic name *Siphogenerina* of Schlumberger is the next available name and is here used.

SIPHOGENERINA COLUMELLARIS (H. B. Brady).

Plate 47, figs. 2, 3.

Sagrina columellaris H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 64; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 581, pl. 75, figs. 15–17.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 36.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 8, 1900, p. 391, fig. 41.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 270, pl. 5, figs. 10, 11.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 151.

Siphogenerina columellaris EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 316, pl. 9, figs. 28, 31, 33; vol. 21, 1899, p. 134, pl. 16, figs. 20, 21.—SILVESTRI, Atti Pont. Accad. Nuovi Lincei, ann. 55, 1902, p. 1, figs. 1, 2.

Siphogenerina glabra SCHLUMBERGER, Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 118, pl. 3, fig., 1.

Description.—Test elongate, subcylindrical, somewhat tapering, straight or very slightly curved; chambers comparatively few; those of the uniserial portion well rounded, shorter than broad, sutures only slightly constricted; aperture large, terminal, with a very short tubular neck and broad flaring lip; wall smooth.

Length about 1 mm.

Distribution.—The only published North Pacific records are those given by Bagg. These are seven *Albatross* stations in the vicinity of the Hawaiian Islands, 104 to 1,544 fathoms. I have found the species fairly common in the region from near the Hawaiian Islands, *Albatross* H2922 in 268 fathoms, *Nero* 2071 in 271 fathoms, and off the coast of Japan, D4968 in 253 fathoms. It has occurred also in the *Nero* material from numerous stations on the line of soundings between Yokohama and Guam in 1,208 to 1,660 fathoms. This species has been found at three *Tuscarora* stations, 57 and 58, in 814 and 1,331 fathoms near the Bonin Islands and at station 15 in 1,874 fathoms south of the Midway Islands. The bottom temperatures where recorded are 44.8° and 45.7° F. off Japan and the Hawaiian Islands, but at the deeper *Nero* soundings go down to 35° F.

SIPHOGENERINA BIFRONS (H. B. Brady).

Plate 45, figs. 1, 2, 5–7.

Sagrina bifrons H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 64; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 582, pl. 75, figs. 18–20.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 21, 1899, p. 134, pl. 15, figs. 25, 26.—Millett, Journ. Roy. Micr. Soc., 1903, p. 270.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 415.

Siphogenerina (*Sagrina*) *bifrons* Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 317, pl. 9, figs, 25, 26, 29.

Description.—Test elongate, compressed, straight or very slightly curved, in end view elliptical, median portions of the broad faces somewhat concave, megalospheric form with the apical end broadly rounded and of about the same diameter as the rest of the test, microspheric form with the apical end much more attenuate, growing rapidly broader, then contracted where the uniserial portion begins; sutures hardly depressed, distinct, often of clear material, appearing darker than the rest of the test; aperture rounded, without a distinct neck but with a slight rounded lip; microspheric form usually the larger.

Length 0.75 to 1 mm.

Distribution.—Brady described this species from material dredged in 345 fathoms on the *Hyalonema*-ground off southeastern Japan. This is the only locality noted in the *Challenger* Report. It has been recorded by Egger off west Australia, by Millett from the Malay Archipelago, and by Chapman from about Funafuti. Apparently the species belongs to a warm-water fauna reaching its northern limit off Japan. Egger's material was from 560 fathoms, Millett's material from shallow water, while Chapman's specimens were from 2,400 fathoms, but the occurrence in deep water off oceanic islands has been several times referred to.

In the material which I have examined the species has occurred at several stations off southeastern Japan in the region from which Brady's types came. These stations have depths of from 191 to 500 fathoms. It was also found to be frequent off the Philippines, occurring at *Nero* station 849 in 737 fathoms.

As is usual in other species the microspheric form occurs less frequently than the megalospheric and the latter does not attain as large dimensions. The two may be distinguished at a glance as the megalospheric form, which is represented in all of Brady's figures, is bluntly rounded, the early portion being of about the same diameter as the later developed, uniserial portion. In the microspheric form the early portion is more acute and tapering, the test above being contracted at the beginning of the uniserial portion.

Occasionally specimens of this species show traces of delicate striations.

One point of particular significance is the fact shown in fig. 5, where it may be seen that in the microspheric form there is a tendency toward a spiral development in the earliest chambers. This shows the relationship of this genus to close coiled genera such as *Cristellaria* and its probable development from a close coiled form.

The relation of the interior tubular structure to the walls of the test is diagrammatically shown in fig. 7.

In four cases the bottom temperature is given for the stations at which this species has occurred. They are 39.1°, 44.1°, 45.7°, and 49.4° F. These are all off the coast of Japan, and as will be seen are rather higher than bottom temperatures run as a rule. This may have a definite bearing on the distribution in this species.

SIPHOGENERINA DIMORPHA (Parker and Jones).

Plate 45, figs. 3, 4.

Uvigerina (*Sagrina*) *dimorpha* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 420, pl. 18, fig. 18.

Sagrina dimorpha H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 582, pl. 76, figs. 1–3.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 225, pl. 45, fig. 6.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 52, pl. 9, figs. 510, 511.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 152.

Siphogenerina dimorpha Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 317, pl. 9, fig. 30.

Description.—Test nearly cylindrical, elongate, slightly tapering, usually broadest near the apertural end, chambers comparatively few, broader than long, slightly inflated; sutures distinct, usually somewhat excavated at nearly regular intervals, the portions between extended backward and bridging over the suture; walls with comparatively large pitted depressions or perforations; aperture circular with a very short neck and flaring lip.

Length 0.5 to 0.8 mm.

Distribution.—Bagg records this species from three *Albatross* stations in the vicinity of the Hawaiian Islands, in 572 to 1,259 fathoms. In the same region it occurs at *Albatross* station H3007 in 323 fathoms. In the western Pacific it has occurred off the coast of Japan, *Albatross* station D4957 in 437 fathoms. It also occurred at *Nero* stations 1306 and 1311 in 1,208 and 1,503 fathoms and at two *Tuscarora* stations 47 and 58 in 1,499 and 814 fathoms. These last four stations are not far from the Bonin Islands. At D4957 the bottom temperature was 39.8°, but it is not recorded from the other stations.

This species is more widely distributed than others of the genus, both in depth and area. It is characteristic in its appearance and can easily be distinguished.

Goës [1] refers to this species a form which is evidently a *Clavulina*, as his figures and description show. Later he figured a specimen in his work on the Scandinavian Foraminifera [2] which very clearly belongs to this species.

The interior has the characteristic tubular structure as shown in fig. 4, *c*.

SIPHOGENERINA STRIATA (Schwager).

Plate 47, figs. 4, 5.

Dimorphina striata Schwager, *Novara* Exped., Geol. Theil., vol. 2, 1866, p. 251, pl. 7, fig. 99.

Sagraina striata Schwager, Bull. Comm. geol. Ital., vol. 8, 1877, p. 25, pl., fig. 35.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1894, p. 584, pl. 75, figs. 25, 26.—Millett, Journ. Roy. Micr. Soc., 1903, p. 272.

Siphogenerina (*Sagrina*) *striata* Egger [?], Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 316, pl. 9, figs. 32, 34, 35, 64, 65.

Description.—Test elongate, cylindrical, chambers of the uniserial portion broader than long, sutures not deep but conspicuous, wall ornamented by longitudinal costæ, not close together and not high; aperture circular with no neck but a prominent rounded lip.

Length 0.75 to 1 mm.

Distribution.—Brady records this species at one North Pacific station off the Philippines in 95 fathoms. I have found specimens from the vicinity of the Hawaiian Islands, *Nero* station 2035, in 114 fathoms, *Nero* Station 1466, off Guam, 234 fathoms, and a specimen which can be referred here from *Nero* station 1321, southeast of the Bonin Islands in 1,618 fathoms.

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[1] Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 62, pl. 4, figs. 77–81.

[2] Idem, vol. 25, No. 9, 1894, pl. 9, figs. 510, 511.

From the original figure given by Schwager this recent form would seem to be distinct in the large aperture which is without a neck, the chambers low and broad, while the figure given by Schwager shows a typical *Uvigerina* aperture, the neck long and slender and the chambers as long as broad and much more inflated. I am inclined to think that our recent species figured here is distinct, but more material is necessary to establish this view.

SIPHOGENERINA RAPHANUS (Parker and Jones).

Plate 46, figs. 1–5.

Uvigerina (*Sagrina*) *raphanus* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 364, pl. 18, figs. 16, 17.

Sagrina raphanus H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 585, pl. 75, figs. 21–24.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 272.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 415.

Siphogenerina (*Sagrina*) *raphanus* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 317, pl. 9, fig. 36.

Siphogenerina costata SCHLUMBERGER, Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 118, fig. 13.

Description.—Test elongate, cylindrical, or tapering, chambers of the uniserial portion broader than long; surface marked by several rather widely separated, well-developed costæ, each extending nearly the length of the test and not affected by the sutures; aperture typically with a short tubular neck and well-developed flaring lip.

Length 0.5 to 1 mm.

Distribution.—Brady records the occurrence of this species from off the Philippines in 95 fathoms, off the coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms and in the volume of the *Challenger* "Report on the Summary of Results," from station 232 in 345 fathoms on the *Hyalonema*-ground southeast of Japan. I have material from *Albatross* stations off Japan in this same region, D4916 in 361 fathoms and D4807 in 44 fathoms. It occurs also at *Nero* station 1306, between Yokohama and Guam, in 1,208 fathoms, and *Nero* station 2071 in 271 fathoms near the Hawaiian Islands. The only temperature records are from D4916, where the bottom temperature was 42.7°.

Both megalospheric and microspheric specimens were seen and figured by Brady, who notes the much larger size of the latter. The form, too, is different, the microspheric form being much more tapering.

SIPHOGENERINA STRIATULA, new species.

Plate 47, fig. 1.

Description.—Test elongate, subcylindrical; chambers for the most part broader than long, but the terminal one nearly as long as broad; sutures slightly indented; surface ornamented with fine longitudinal striæ; aperture narrowly elongate, without a neck, but a well-developed lip present.

Length about 1 mm.

Distribution.—This species has occurred at numerous stations in the region between Yokohama and Guam, depths ranging from 859 fathoms to 1,660 fathoms. Type, Cat. No. 8552, U.S.N.M., from *Nero* station 1472 in 1,000 fathoms. No bottom temperatures are recorded for any of the stations at which this species has occurred, but where they are given from adjacent stations they are below 40° F.

The fine striate surface and the form of the aperture will serve to distinguish this species.

SIPHOGENERINA IRREGULARIS (Bagg).

Plate 47, figs. 6, 7.

Sagraina irregularis Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 152, pl. 5, figs. 8-10.

Description.—Test elongate, subcylindrical; chambers somewhat irregular, but becoming uniserial in the later developed portion; variable as regards height of individual chambers; surface ornamented with very fine costæ; wall thin and translucent, apertural end of the chamber depressed; aperture slightly excentric, with a long tubular neck and a slightly flaring lip.

Length 0.75 to 1.50 mm.

Distribution.—Bagg described this species from *Albatross* material dredged near the Hawaiian Islands, D4025 in 275 to 368 fathoms and H4571 in 384 fathoms. I have found the species at four stations in this same region, *Albatross* H2922, H2923, and H2986 in 268, 392, and 271 fathoms. It also occurred at *Nero* station 2071, in 271 fathoms. But one station, H2922, has the bottom temperature recorded, this being 44.8° F. However, the adjacent station to H2986 at nearly the same depth has a recorded temperature of 48.1° F. Evidently this species is a somewhat local one, but is to be watched for elsewhere under similar conditions. This belongs to *Siphogenerina*, as is shown by the figure of the interior, fig. 7.

There is a specimen from *Nero* station 166 in 1,850 fathoms northeast of Midway Island, which has many of the characteristics of this species, but the costæ are much coarser. It may be a deep-water form of this species. Bagg speaks of this species as resembling *S. striata* (Schwager), but it much more closely resembles the figure given by Schwager[1] and named by him *Uvigerina nitidula*.

SIPHOGENERINA (?) ANNULATA (H. B. Brady).

Plate 37, figs. 8, 9.

Sagrina (?) *annulata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 586, pl. 76, figs. 20, 21.

Description.—"Test subcylindrical; oral end rounded, aboral extremity obtusely angular or rounded; composed of few (two to four), elongate, somewhat inflated segments, united end to end. Surface marked by closely set, slightly depressed, transverse lines. Aperture a simple terminal rounded orifice."

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[1] *Novara* Exped., Geol. Theil, vol 2, 1867, pl. 7, fig 93.

"Length $\frac{1}{35}$ inch (0.75 mm.)."

Distribution.—Described by Brady from material dredged from Honolulu coral reefs in 40 fathoms.

The description and figures are from Brady. He questions whether or not the species may be a *Sagrina* and until further material may be found its affinities can not clearly be determined.

Subfamily 5. RAMULININÆ.

Test composed of branching tubular masses with rounded chamber-like portions at irregular intervals.

Genus RAMULINA Rupert-Jones, 1875.

Ramulina Rupert-Jones (type, *R. lævis* Rupert-Jones) in Wright, Rep. Proc. Belfast Nat. Field Club, 1873–74, App. III, 1875, p. 88 [90].

Description.—Test free, branching, consisting of more or less round chambers connected by long stoloniferous tubes; wall hyaline.

This genus includes rather ill-defined forms, suggesting the so-called "wild growth" seen in the final chambers of certain species of *Polymorphina.* Just what its relations are to the rest of the Lagenidæ is not really determined. It seems to occur in the Cretaceous and there are one or two recent species.

RAMULINA GLOBULIFERA H. B. Brady.

Plate 39, fig. 1.

Ramulina globulifera H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 58, pl. 8, figs. 32, 33; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 587, pl. 76, figs. 22–28.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 310, pl. 9, fig. 62.—De Amicis, Naturalista Siciliano, ann. 14, 1895, p. 112, pl. 1, fig. 14.—Chapman, Proc. Zool. Soc. London, 1895, p. 36; Journ. Roy. Micr. Soc. 1896, p. 582, pl. 12, figs. 3–6.—Jones and Chapman, Journ. Linn. Soc. Zool., vol. 26, 1897, p. 340, figs. 5–22.—Egger, Abh. kön. bay. Acad. Wiss. München, Cl. ii, vol. 21, 1899, p. 135, pl. 2, fig. 2, pl. 22, fig. 33.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 321, pl. 68, fig. 6.—Millett, Journ. Roy. Micr. Soc. 1903, p. 274.—Benham, Trans. New Zealand Inst., vol. 37, 1904 (1905), p. 300.—Chapman, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 99.

Description.—Test free, branching, composed of nearly globular chambers connected by stolon-like tubes; wall hyaline, usually hispid; apertures tubular, often several to a single chamber.

Length up to nearly 2 mm.

Distribution.—Brady records the species from a single *Challenger* station off the Philippines in 95 fathoms. I have had specimens from *Albatross* station D4949, off Japan, in 110 fathoms.

EXPLANATION OF PLATES.

PLATE 1.

Fig. 1. *Lagena lateralis.* × 125. *a*, front view by transmitted light; *b*, apertural view; *c*, front view; *d*, side view.

2. *Lagena collaris.* × 125. *a*, front view; *b*, same by transmitted light; *c*, apertural view.

3. *Lagena lævis.* × 65. *a*, front view; *b*, side view; *c*, apertural view.

4. *Lagena gracillima.* × 65. *a*, front view; *b*, apertural view.

5. *Lagena elongata.* × 35. *a*, front view; *b*, apertural view.

PLATE 2.

Fig. 1. *Lagena lævigata.* × 65. *a*, front view; *b*, apertural view; *c*, front view by transmitted light.

2. *Lagena ovum.* × 125. *a*, front view; *b*, same by transmitted light; *c*, apertural view.

3. *Lagena clavata.* × 125. *a*, front view; *b*, apertural view.

PLATE 3.

Figs. 1–3. *Lagena sacculus.* 1. Form with slight development of keel × 65. *a*, apertural view; *b*, front view; *c*, same by transmitted light.

2. Form with medium keel × 65. *a*, apertural view; *b*, front view; *c*, same by transmitted light.

3. Form with broad keel × 125. *a*, apertural view; *b*, front view; *c*, same by transmitted light.

PLATE 4.

Fig. 1. *Lagena felsinea.* × 75. *a*, front view; *b*, same by transmitted light; *c*, apertural view.

2. *Lagena globosa.* *a*, front view, × 75; *b*, apertural view, × 75; *c*, optical section, × 40.

3. *Lagena ampulla-distoma*, var. *cribrostomoides.* *a*, front view, × 90; *b*, basal view, × 90; *c*, view of aperture, × 300.

4. *Lagena hispida.* × 150. *a*, front view; *b*, apertural view.

5. *Lagena hispida.* × 90. *a*, front view; *b*, apertural view.

PLATE 5.

Fig. 1. *Lagena hispida.* × 90.

2. *Lagena hispidula.* × 90. *a*, front view; *b*, apertural view.

3. *Lagena hispidula.* × 90.

4. *Lagena punctulata.* *a*, front view, × 90; *b*, apertural view, × 90; *c*, portion of surface, × 300.

5. *Lagena hystrix.* *a*, front view, × 90; *b*, apertural view, × 90; *c*, portion of surface, × 300.

PLATE 6.

Fig. 1. *Lagena squamosa.* × 125. *a*, front view; *b*, apertural view.

2. *Lagena hexagona.* × 65. *a*, front view, *b*, apertural view in outline; *c*, detail of aperture.

3. *Lagena hexagona.* × 125. *a*, front view; *b*, apertural view in outline.

4. *Lagena hexagona*, var. *scalariformis.* × 125.

PLATE 7.

Fig. 1. *Lagena catenulata.* × 150. *a*, front view; *b*, apertural view.
2. *Lagena catenulata.* × 75.
3. *Lagena foveolata.* × 75. *a*, front view; *b*, apertural view.
4. *Lagena striata.* × 75.
5. *Lagena striata.* × 75.
6. *Lagena striata*, var. *haidingeri.* × 75. *a*, front view; *b*, apertural view.
7. *Lagena striata*, var. *strumosa.* × 90.
8. *Lagena striata*, var. *strumosa.* × 90.
9. *Lagena striata*, var. *strumosa*, neck. × 150.
10. *Lagena striata*, var. *strumosa*, neck. × 150.

PLATE 8.

Fig. 1. *Lagena striata*, var. *substriata*, elongate form. × 150. *a*, front view; *b*, apertural view.
2. *Lagena striata*, var. *substriata.* × 150.
3. *Lagena striata*, var. *substriata.* × 180. Apertural portion of unbroken specimen showing spiral ornamentation of neck.
4. *Lagena mucronulata.* × 75.
5. *Lagena gracilis.* × 75. *a*, front view; *b*, apertural view.
6. *Lagana gracilis*, neck. × 150.
7. *Lagena gracilis*, var. × 150.
8. *Lagena inferocostata.* × 75. *a*, front view; *b*, apertural view; *c*, basal view.
9. *Lagena acuticosta.* × 75. *a*, front view; *b*, apertural view.
10. *Lagena acuticosta.* × 75.

PLATE 9.

Fig. 1. *Lagena acuticosta*, var. *paucicostata.* × 75. *a*, front view; *b*, apertural view.
2. *Lagena sulcata.* × 75.
3. *Lagena sulcata*, var. *apiculata.* × 75. *a*, front view; *b*, apertural view.
4. *Lagena sulcata*, var. *apiculata.* × 90.
5. *Lagena sulcata*, var. *alticostata.* × 75. *a*, front view; *b*, apertural view.
6. *Lagena costata.* × 75.

PLATE 10.

Fig. 1. *Lagena costata.* × 45. *a*, front view; *b*, same by transmitted light; *c*, apertural view.
2. *Lagena costata*, var. *amphora.* × 150.
3. *Lagena costata*, var. *amphora.* × 75.
4. *Lagena costata*, var. *polygonata.* × 90. *a*, front view; *b*, apertural view.

PLATE 11.

Fig. 1. *Lagena unguiculata.* × 60.
2. *Lagena seminiformis.* × 45.
3. *Lagena torquata.* × 75.
4. *Lagena orbignyana*, var. *clathrata.* × 75.
5. *Lagena favoso-punctata.* × 75.
6. *Lagena formosa.* × 50.
7. *Lagena formosa*, var. *favosa.* × 60.
8. *Lagena formosa*, var. *comata.* × 75.

PLATE 12.

Fig. 1. *Lagena costata*, oval form. × 90. *a*, front view; b, apertural view.
2. *Lagena costata*, var. *amphora*. × 90. *a*, front view; *b*, apertural view.
3. *Lagena stelligera*. × 75. *a*, front view; *b*, apertural view; *c*, basal view.
4. *Lagena plumigera*. × 75. *a*, front view; *b*, apertural view.
5. *Lagena desmophora*. × 90. *a*, front view; *b*, apertural view.

PLATE 13.

Fig. 1. *Lagena distoma*. × 75. *a*, front view; *b*, apertural view.
2. *Lagena distoma*. × 75. *a*, front view; *b*, apertural view.
3. *Lagena desmophora*. × 75. *a*, front view; *b*, apertural view.
4. *Lagena intermedia*. × 90. *a*, front view; *b*, apertural view.
5. *Lagena exsculpta*. × 35. *a*, front view; *b*, apertural view.

PLATE 14.

Fig. 1. *Lagena quadricostulata*. × 75.
2. *Lagena auriculata*, var. *costata*. × 60. *a*, front view; *b*, apertural view.
3. *Lagena trigono-marginata*. × 100. *a*, front view; *b*, apertural view.
4. *Lagena trigono-marginata*. × 100.
5. *Lagena striato-areolata*. × 100.
6. *Lagena striato-areolata*. × 100. Portion of the surface.
7. *Lagena ampulla-distoma*. × 60.
8. *Lagena fimbriata*. × 60.
9. *Lagena quadrata*. × 75.
10. *Lagena striato-punctata*. × 75.

PLATE 15.

Fig. 1. *Lagena feildeniana*. *a*, front view, × 150; *b*, apertural view, × 150; *c*, portion of surface enlarged, × 375.
2. *Lagena feildeniana*. × 150. Specimen with wider intercostal areas and higher, more acute costæ. *a*, front view; *b*, apertural view.
3. *Lagena foveolata*, var. *paradoxa*. *a*, front view, × 75; *b*, enlarged portion of surface, × 150.

PLATE 16.

Fig. 1. *Lagena aspera*. × 90.
2. *Lagena lagenoides*. × 150.
3. *Lagena lagenoides*, var. *tenuistriata*. × 150. *a*, front view; *b*, side view.
4. *Lagena sublagenoides*. × 75. *a*, front view; *b*, apertural view.
5. *Lagena sublagenoides*, var. *striatula*. × 75.

PLATE 17.

Fig. 1. *Lagena crescenticostata*. × 75. *a*, front view; *b*, side view.
2. *Lagena crescenticostata*. × 75. Specimen with more simple ornamentation.
3. *Lagena staphyllearia*. × 45. *a*, front view; *b*, apertural view.
4. *Lagena auriculata*, var. *subcarinata*. × 150. *a*, front view; *b*, side view.
5. *Lagena auriculata*, var. *linearituba*. × 75. *a*, front view; *b*, side view.

PLATE 18.

Fig. 1. *Lagena alveolata*. × 75. *a*, front view; *b*, side view.
2. *Lagena alveolata*, var. *plebeia*. × 90. *a*, front view; *b*, side view.
3. *Lagena alveolata*, var. *prolongata*. × 75.
4. *Lagena alveolata*, var. *basiexcavata*. × 75.
5. *Lagena alveolata*, var. *substriata*. × 75.

PLATE 19.

Fig. 1. *Lagena orbignyana.* × 90. *a*, front view; *b*, apertural view.
2. *Lagena orbignyana*, var. *concentrica.* × 90. *a*, front view; *b*, side view.
3. *Lagena truncata.* × 45. *a*, front view; *b*, same by transmitted light; *c*, side view; *d*, apertural view.
4. *Lagena quadrata*, var. *rizzæ.* × 75.

PLATE 20.

Fig. 1. *Lagena orbignyana*, var. *lacunata.* × 150. *a*, front view; *b*, apertural view.
2. *Lagena orbignyana*, var. *crenulata.* × 150. *a*, front view; *b*, apertural view.
3. *Lagena orbignyana*, var. *coronata.* × 45. *a*, front view; *b*, side view.

PLATE 21.

Fig. 1. *Lagena fasciata*, var. *carinata.* × 133. *a*, front view; *b*, apertural view.
2. *Lagena marginata*, var. × 65. *a*, front view; *b*, apertural view.
3. *Lagena marginata*, var. × 65. *a*, front view; *b*, side view.
4. *Lagena apiculata.* × 45. *a*, front view; *b*, side view.

PLATE 22.

Fig. 1. *Lagena marginata.* × 133. *a*, front view; *b*, apertural view.
2. *Lagena marginata.* × 133. *a*, front view; *b*, apertural view.
3. *Lagena marginata.* × 133. Specimen by transmitted light.
4. *Lagena marginata.* × 133. Specimen with broad keel.
5. *Lagena marginata.* × 65. Specimen with keel resembling *L. lagenoides.*
6. *Lagena marginata.* × 65. Specimen with narrow keel by transmitted light.
7. *Lagena marginata.* × 65. Specimen showing irregularly striate surface.

PLATE 23.

Fig. 1. *Lagena orbignyana*, var. *alata.* × 150.
2. *Lagena acuticosta.* × 75. *a*, front view; *b*, apertural view.
3. *Marginulina glabra.* × 40. *a*, front view; *b*, apertural view.
4. *Marginulina striatula.* × 40. *a*, front view; *b*, side view; *c*, apertural view.
5. *Frondicularia bradyi.* × 75. *a*, front view; *b*, apertural view.

PLATE 24.

Fig. 1. *Nodosaria (Glandulina) laevigata.* × 30. Specimen with twin spines at base.
2. *Nodosaria (Glandulina) laevigata.* × 30. *a*, front view; *b*, view of aperture.
3. *Nodosaria mucronata.* × 30. Outline.
4. *Nodosaria roemeri.* × 65. *a*, front view; *b*, apertural view.
5. *Nodosaria roemeri.* × 65. *a*, front view; *b*, apertural view.
6. *Nodosaria roemeri.* × 65. Two-chambered stage.
7. *Nodosaria scalaris.* × 40. *a*, front view; *b*, apertural view.

PLATE 25.

Fig. 1. *Nodosaria inflexa.* × 75.
2. *Nodosaria mucronata.* × 40. *a*, front view; *b*, apertural view.
3. *Nodosaria catenulata.* × 75. *a*, front view; *b*, same by transmitted light; *c*, apertural view.
4. *Nodosaria haueriana.* × 75. *a*, front view; *b*, apertural view.
5. *Nodosaria obliqua.* × 15. *a*, front view; *b*, apertural view.
6. *Nodosaria calomorpha.* × 75. *a*, front view; *b*, outline of same by transmitted light; *c*, apertural view.
7. *Nodosaria pauperata.* × 40. *a*, front view; *b*, apertural view.

PLATE 26.

Figs. 1–3. *Nodosaria pyrula.* × 30–40. 1*a*, front view; 1*b*, apertural view.
4–8. *Nodosaria pyrula*, var. *semirugosa.* Fig. 6, × 30. Others, × 15.
9–11. *Nodosaria soluta.* × 12. 10*a*, front view; 10*b*, apertural view.
12, 13. *Nodosaria raphanus.* × 15. 13*a*, front view; 13*b*, apertural view.

PLATE 27.

Fig. 1. *Nodosaria filiformis.* × 65. Outline by transmitted light.
2. *Nodosaria filiformis.* × 65.
3. *Nodosaria filiformis.* × 33. *a*, front view; *b*, apertural view.
4. *Nodosaria filiformis.* × 33. *a*, front view; *b*, same by transmitted light.
5. *Nodosaria mucronata.* × 65. *a*, front view; *b*, apertural view.
6. *Nodosaria mucronata.* × 65. Outline of chambers by transmitted light.
7. *Nodosaria mucronata.* × 65. Outlines of chambers.
8. *Nodosaria longirostrata.* *a*, front view of last two chambers × 33; *b*, apertural end × 133.
9. *Nodosaria consobrina*, var. *emaciata.* × 16. *a*, front view; *b*, apertural view.

PLATE 28.

Fig. 1. *Nodosaria communis.* × 20. *a*, front view; *b*, apertural view.
2. *Nodosaria communis.* × 33. Outline of chambers.
3. *Nodosaria hirsuta.* × 65.
4. *Nodosaria japonica.* *a*, front view, × 12; *b*, last-formed chamber, × 50; *c*, apertural view, × 50.
5. *Nodosaria simplex.* × 33. *a*, front view; *b*, apertural view.
6. *Nodosaria* (*Glandulina*) *rotundata.* × 33. *a*, front view; *b*, apertural view.
7. *Nodosaria abyssorum.* × 33. *a*, front view; *b*, apertural view.

PLATE 29.

Fig. 1. *Frondicularia robusta*, var. *repanda.* × 30. *a*, front view; *b*, apertural view.
2. *Frondicularia robusta*, var. *repanda.* × 30. A more irregular specimen.
3. *Lingulina carinata.* × 20. *a*, front view; *b*, apertural view.
4. *Cristellaria cultrata.* × 25. *a*, side view; *b*, face view.
5. *Cristellaria crepidula.* × 90. Outline of chambers.
6. *Cristellaria crepidula.* × 60. Outline of chambers.

PLATE 30.

Fig. 1. *Vaginulina protumida.* × 30.
2. *Polymorphina ovata.* × 25. *a*, front view; *b*, apertural view.
3. *Polymorphina sororia.* × 75. *a*, front view; *b*, apertural view.
4. *Cristellaria reniformis.* × 35. *a*, side view; *b*, face view.
5. *Cristellaria subalata.* × 25. Side view.
6. *Cristellaria subalata.* × 60. Basal wing.
7. *Cristellaria subalata.* × 60. Basal wing, × 60.

PLATE 31.

Fig. 1. *Cristellaria articulata.* × 30. *a*, side view; *b*, face view.
2. *Cristellaria crepidula.* × 60.
3. *Cristellaria crepidula.* × 30. *a*, face view; *b*, side view.
4. *Cristellaria crepidula.* × 60. Outline of chambers.
5. *Cristellaria crepidula.* × 150. Outlines of chambers by transmitted light.

Plate 32.

Fig. 1. *Nodosaria vertebralis.* × 15.
2. *Cristellaria nitida.* × 30. *a*, side view; *b*, face view.
3. *Cristellaria vortex.* × 30. *a*, side view; *b*, face view.
4. *Cristellaria calcar.* × 35.
5. *Frondicularia robusta.* × 17.
6. *Frondicularia robusta.* × 75. *a*, front view; *b*, apertural view.
7. *Vaginulina patens.* × 75. *a*, side view; *b*, face view.
8. *Vaginulina patens.* × 75.

Plate 33.

Fig. 1. *Cristellaria reniformis.* × 30. *a*, side view; *b*, face view.
2. *Cristellaria tricarinella*, var. *spinipes.* × 30. *a*, side view; *b*, face view.
3. *Cristellaria italica.* × 30. *a*, side view; *b*, face view.
4. *Cristellaria wetherellii*, var. *sublineata.* × 18. *a*, side view; *b*, face view.

Plate 34.

Fig. 1. *Cristellaria tricarinella.* × 50. *a*, side view; *b*, face view.
2. *Cristellaria tricarinella.* × 50.
3. *Cristellaria convergens.* × 50. *a*, side view; *b*, face view.
4. *Cristellaria costata.* × 35.
5. *Cristellaria echinata.* × 20.
6. *Cristellaria mamilligera.* × 20. *a*, side view; *b*, face view.
7. *Cristellaria gemmata.* × 35. *a*, side view; *b*, face view.
8. *Polymorphina lactea.* × 50.

Plate 35.

Fig. 1. *Cristellaria gibba.* × 40. *a*, side view; *b*, face view.
2. *Cristellaria acutauricularis.* × 133. *a*, side view; *b*, face view.
3. *Cristellaria rotulata.* × 20. *a*, side view; *b*, face view.
4. *Cristellaria lata.* × 80. *a*, side view; *b*, face view.
5. *Nodosaria guttifera.* × 33. *a*, front view; *b*, apertural view.
6. *Nodosaria mucronata.* × 65. *a*, front view; *b*, side view, abnormal specimen.

Plate 36.

Fig. 1. *Cristellaria variabilis.* × 65. *a*, side view; *b*, face view.
2. *Cristellaria variabilis.* × 80. *a*, side view; *b*, apertural view.
3. *Cristellaria variabilis.* × 65. Young specimen.
4. *Cristellaria orbicularis.* × 65. *a*, side view; *b*, face view.
5. *Cristellaria orbicularis.* × 65. *a*, side view; *b*, face view.
6. *Cristellaria schloenbachi.* × 50. *a*, side view; *b*, apertural view.
7. *Cristellaria elegantissima.* × 33. *a*, side view; *b*, face view.

Plate 37.

Fig. 1. *Cristellaria denticulifera.* × 20.
2. *Cristellaria papillosa.* × 20.
3. *Uvigerina schwageri.* × 30. *a*, front view; *b*, apertural view.
4. *Uvigerina schwageri.* × 30.
5. *Uvigerina auberiana.* × 40.
6. *Polymorphina oblonga.* × 40. *a*, front view; *b*, apertural view.
7. *Polymorphina communis.* × 50.
8. *Siphogenerina annulata.* × 60. *a*, front view; *b*, apertural view.
9. *Siphogenerina annulata.* × 100. Last chamber.

PLATE 38.

Fig. 1. *Polymorphina elegantissima.* × 33. *a*, front view; *b*, side view; *c*, apertural view.
2. *Cristellaria latifrons.* × 80. *a*, side view; *b*, face view.
3. *Cristellaria* sp. × 33. *a*, side view; *b*, face view.
4. *Cristellaria* sp. × 33. *a*, side view; *b*, face view.
5. *Lagena lævis.* × 133.
6. *Lagena acuta.* × 100. *a*, front view; *b*, same by transmitted light; *c*, apertural view.

PLATE 39.

Fig. 1. *Ramulina globulifera.* × 33. *a*, elongated specimen; *b*, globular portion.
2. *Triplasia tricarinata.* × 80. *a*, specimen with irregular contour; *b*, specimen with regular contour; *c*, apertural view.
3. *Triplasia reussii.* × 65. *a*, side view; *b*, apertural view.
4. *Vaginulina legumen.* × 33. *a*, side view; *b*, apertural view.
5. *Frondicularia bradyi.* × 160. Specimen by transmitted light showing very thick proloculum with radiating tubes.
6. *Polymorphina angusta.* × 65. *a*, side view; *b*, front view; *c*, rear view; *d*, apertural view.

PLATE 40.

Fig. 1. *Polymorphina rotundata.* × 30. *a*, front view; *b*, side view; *c*, apertural view.
2. *Polymorphina lanceolata.* × 60. *a*, front view; *b*, apertural view.
3. *Polymorphina compressa.* × 30. *a*, front view; *b*, apertural view.
4. *Polymorphina ovata*, fistulose form. × 60. *a*, ventral view; *b*, apertural view; *c*, dorsal view.

PLATE 41.

Fig. 1. *Polymorphina longicollis.* × 65. *a*, front view; *b*, apertural view; *c*, side view.
2. *Polymorphina longicollis.* × 65. *a*, front view; *b*, side view.
3. *Polymorphina longicollis*, fistulose form. × 33. *a*, front view; *b*, apertural view.
4. *Polymorphina gibba.* × 33. *a*, front view; *b*, apertural view.
5. *Polymorphina amygdaloides.* × 80. *a*, front view; *b*, apertural view.
6. *Polymorphina regina.* × 65. Young specimen.
7. *Polymorphina regina.* × 65. *a*, front view; *b*, apertural view.
8. *Polymorphina lactea*, var. *diffusa.* × 33. *a*, front view; *b*, apertural view.

PLATE 42.

Fig. 1. *Uvigerina pygmæa.* × 60. *a*, front view; *b*, apertural view.
2. *Uvigerina proboscidea.* × 60. *a*, front view; *b*, apertural view.
3. *Uvigerina ampullacea.* × 30. *a*, front view; *b*, side view.
4. *Uvigerina tenuistriata.* × 60. *a*, front view; *b*, apertural view.
5. *Uvigerina selseyensis.* × 120. *a*, front view; *b*, apertural view.
6. *Uvigerina canariensis.* × 60. *a*, front view; *b*, side view; *c*, apertural view.

PLATE 43.

Fig. 1. *Uvigerina asperula.* × 65. *a*, front view; *b*, apertural view.
2. *Uvigerina brunnensis.* × 65. *a*, front view; *b*, side view; *c*, apertural view.
3. *Uvigerina angulosa*, var. *spinipes.* × 65. *a*, front view; *b*, apertural view.
4. *Uvigerina aculeata.* × 33. *a*, front view; *b*, side view; *c*, apertural view.
5. *Uvigerina striata.* × 65. *a*, front view; *b*, apertural view.

PLATE 44.

Fig. 1. *Uvigerina interrupta.* × 75. *a*, front view; *b*, side view; *c*, apertural view.
2. *Uvigerina porrecta.* × 75. *a*, front view; *b*, front view; *c*, apertural view, a more attenuate specimen.
3. *Uvigerina striatula.* × 75. *a*, front view; *b*, side view; *c*, apertural view.
4. *Uvigerina angulosa.* × 75. *a*, front view; *b*, side view; *c*, apertural view.
5. *Uvigerina pygmæa.* × 75.

PLATE 45.

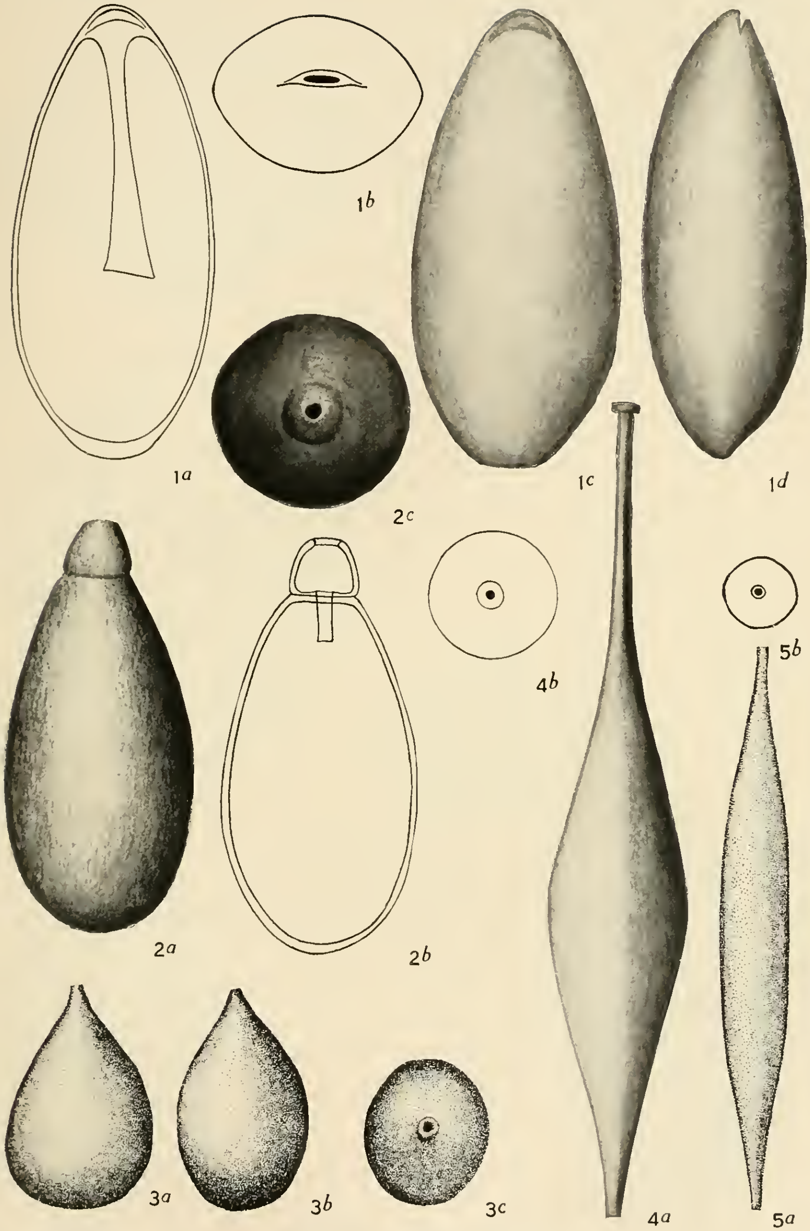
Fig. 1. *Siphogenerina bifrons.* × 75. *a*, front view; *b*, apertural view, microspheric specimen.
2. *Siphogenerina bifrons.* × 75. Megalospheric specimen.
3. *Siphogenerina dimorpha.* × 75. *a*, front view; *b*, apertural view.
4. *Siphogenerina dimorpha.* × 150. Later chambers by transmitted light.
5. *Siphogenerina bifrons.* × 300. Outline of early chamber of microspheric specimen.
6. *Siphogenerina bifrons.* × 75. Outline of megalospheric specimen by transmitted light.
7. *Siphogenerina bifrons.* × 300. Later chambers by transmitted light.

PLATE 46.

Fig. 1. *Siphogenerina raphanus.* × 40. Megalospheric specimen.
2. *Siphogenerina raphanus.* × 40. *a*, front view; *b*, apertural view, microspheric specimen.
3. *Siphogenerina raphanus.* × 225. Outline of early chambers of microspheric specimen.
4. *Siphogenerina raphanus.* × 75. Outline of megalospheric specimen.
5. *Siphogenerina raphanus.* × 75. Later chambers by transmitted light.

PLATE 47.

Fig. 1. *Siphogenerina striatula.* × 75. *a*, front view; *b*, apertural view.
2. *Siphogenerina columellaris.* × 75. *a*, front view; *b*, apertural view.
3. *Siphogenerina columellaris.* × 75. Specimen by transmitted light.
4. *Siphogenerina striata.* × 75. *a*, front view; *b*, apertural view.
5. *Siphogenerina striata.* × 75. Later chambers by transmitted light.
6. *Siphogenerina irregularis.* × 75. *a*, front view; *b*, apertural view.
7. *Siphogenerina irregularis.* × 75. Later chambers by transmitted light.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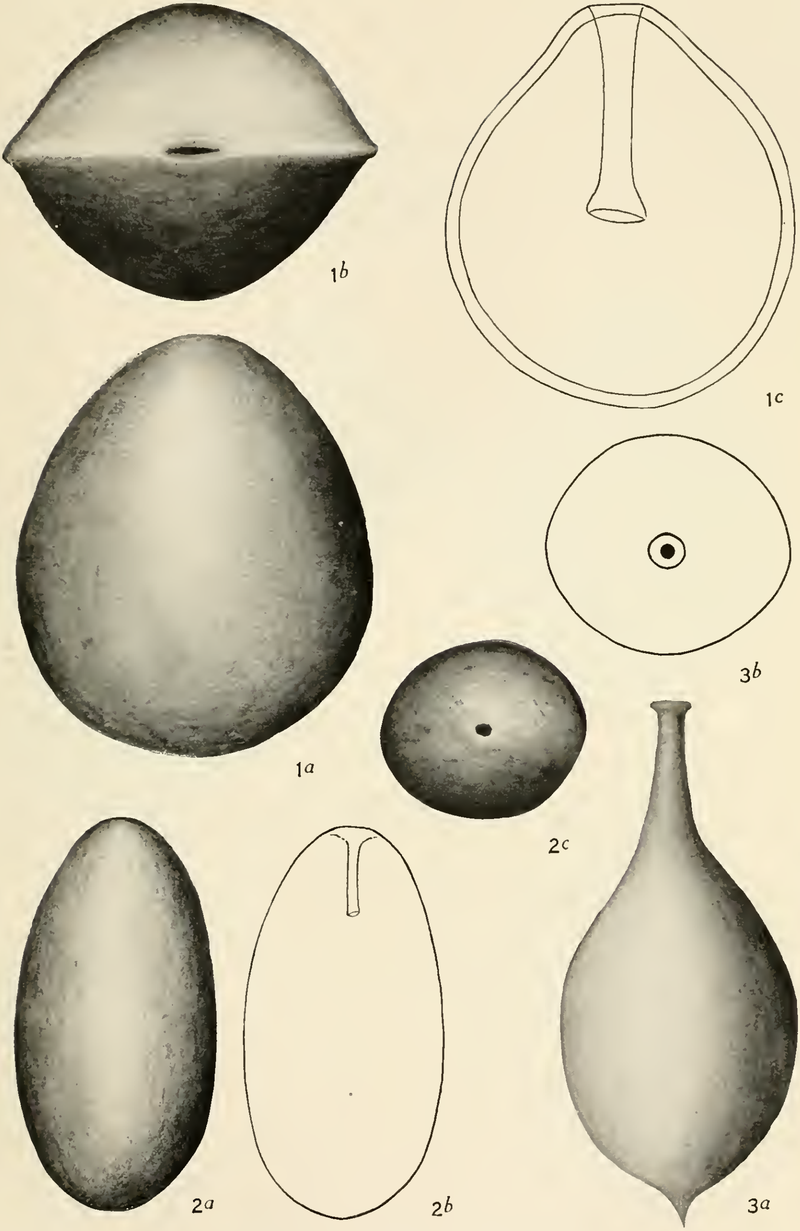
5b

LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 111.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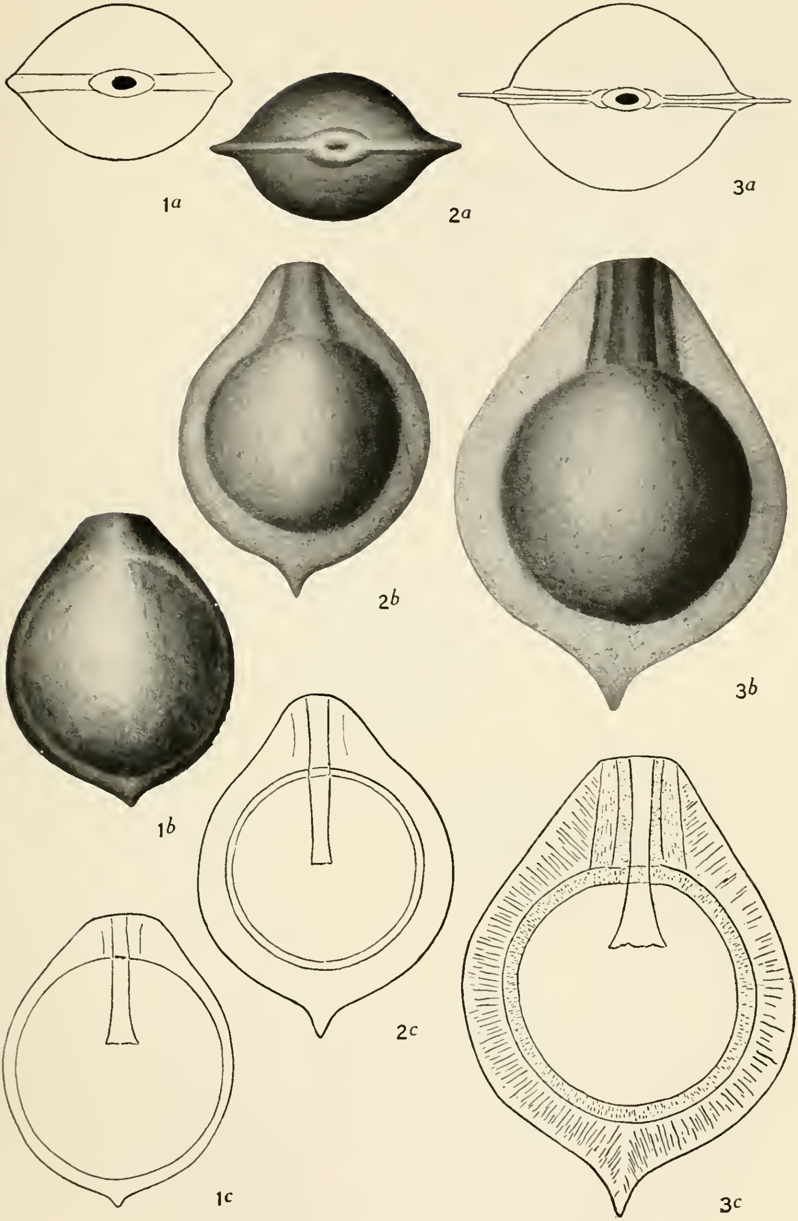
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 111.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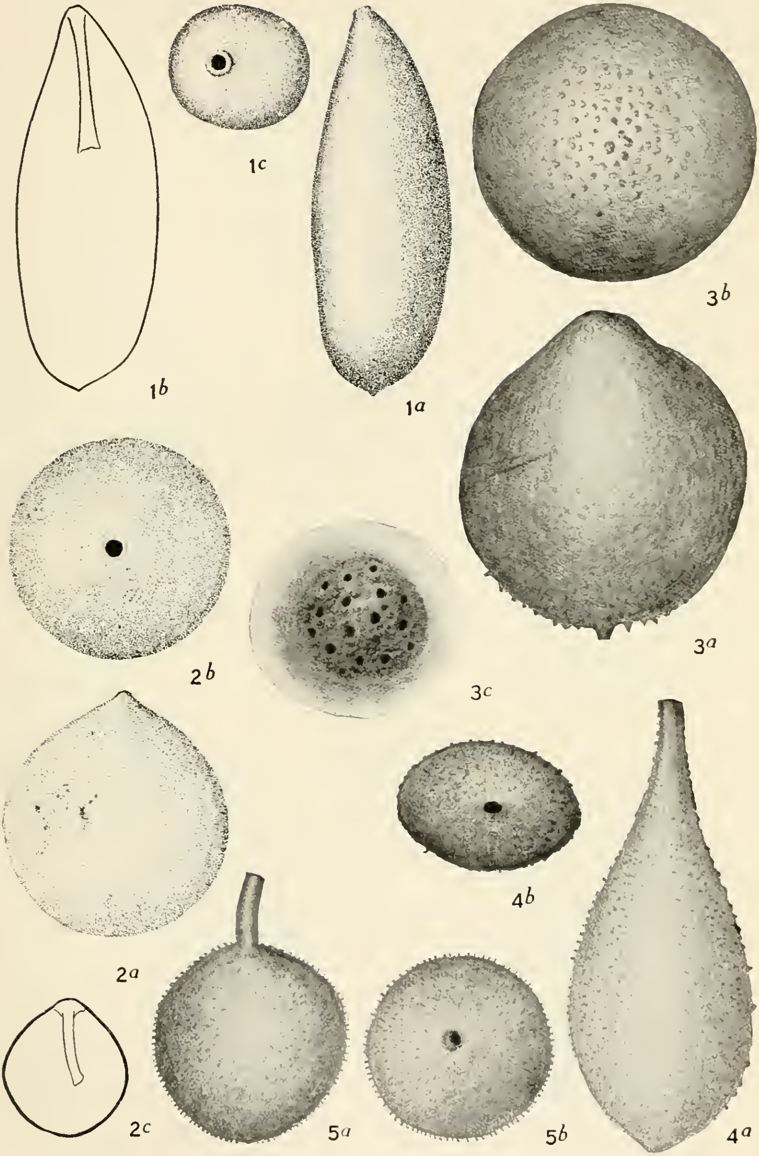
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 111.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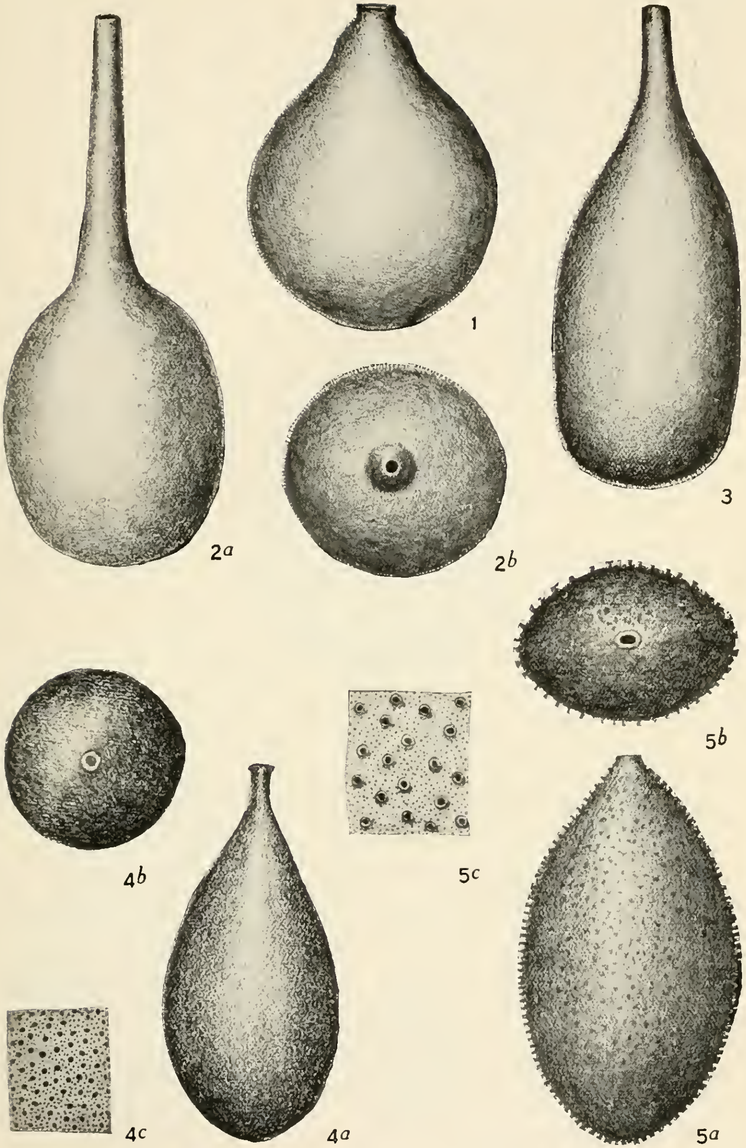
5b
4a

Lagenidæ of North Pacific Ocean.

For explanation of plate see page 111.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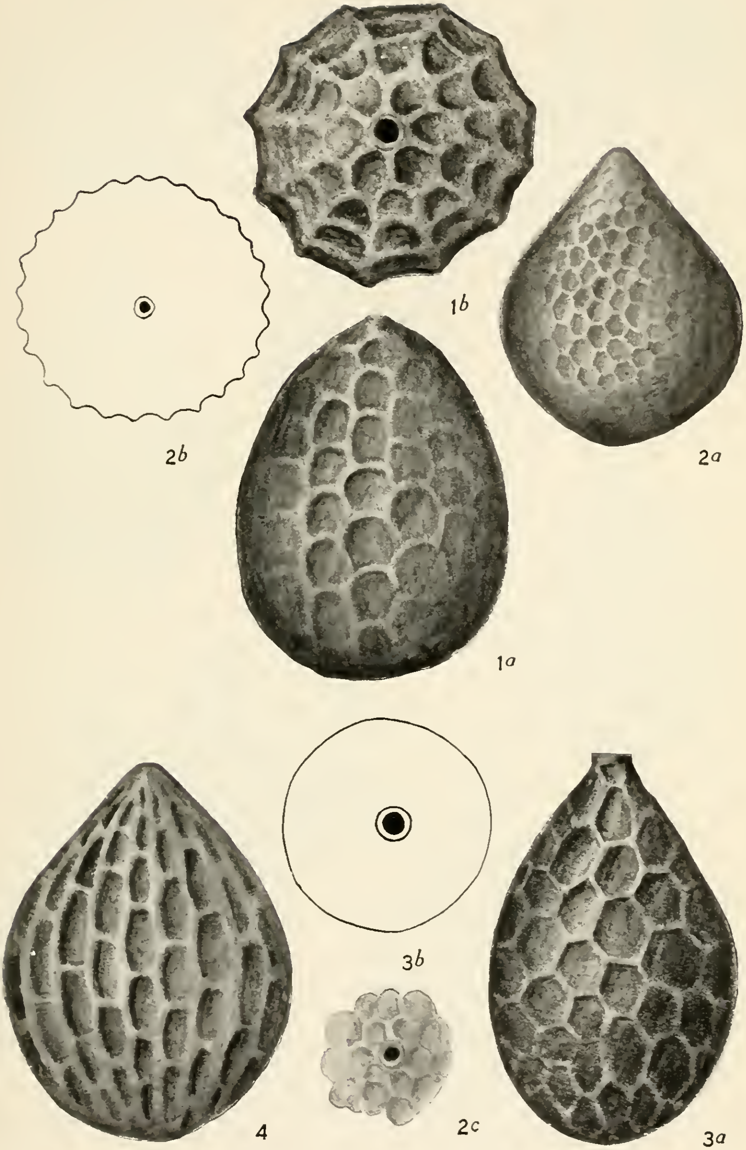
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 111.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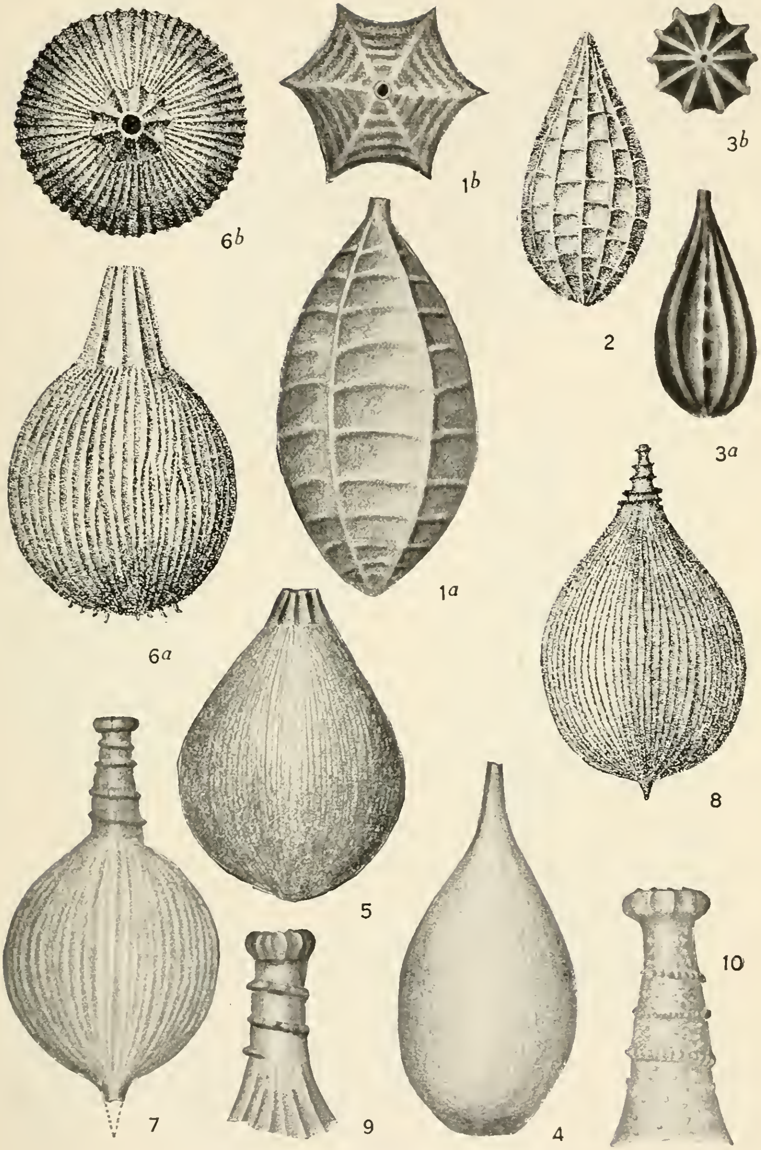
3a

Lagenidæ of North Pacific Ocean.

For explanation of plate see page 111.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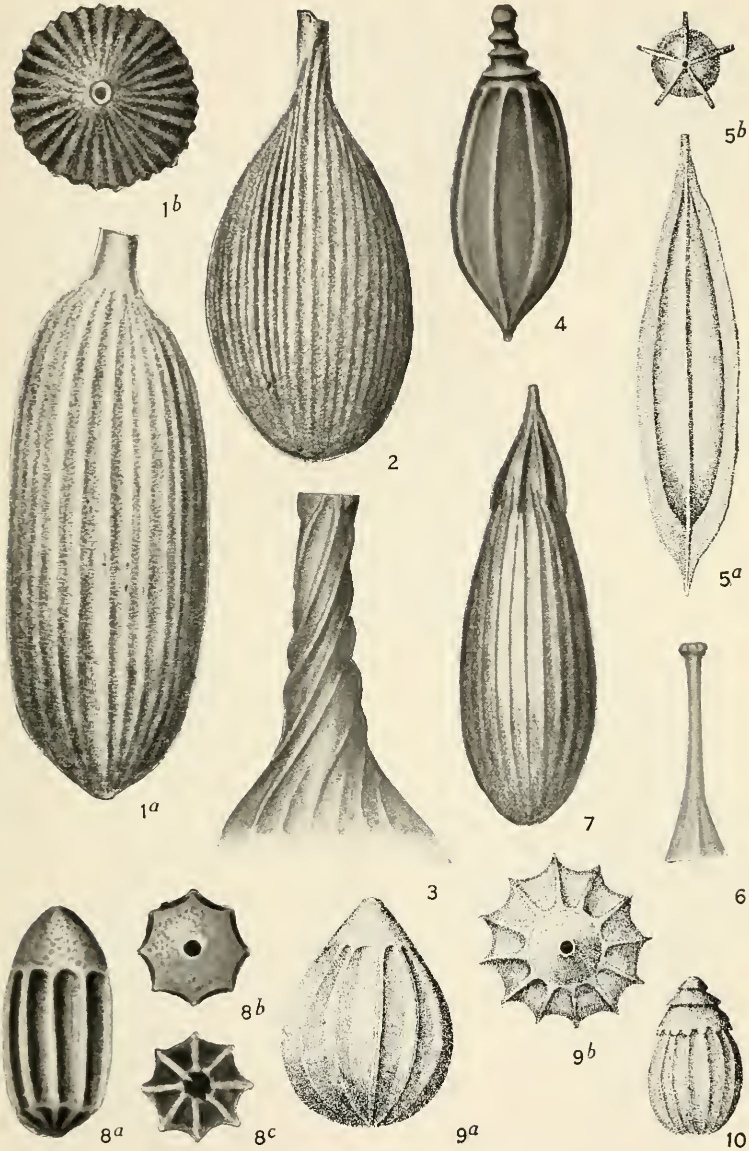
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 112.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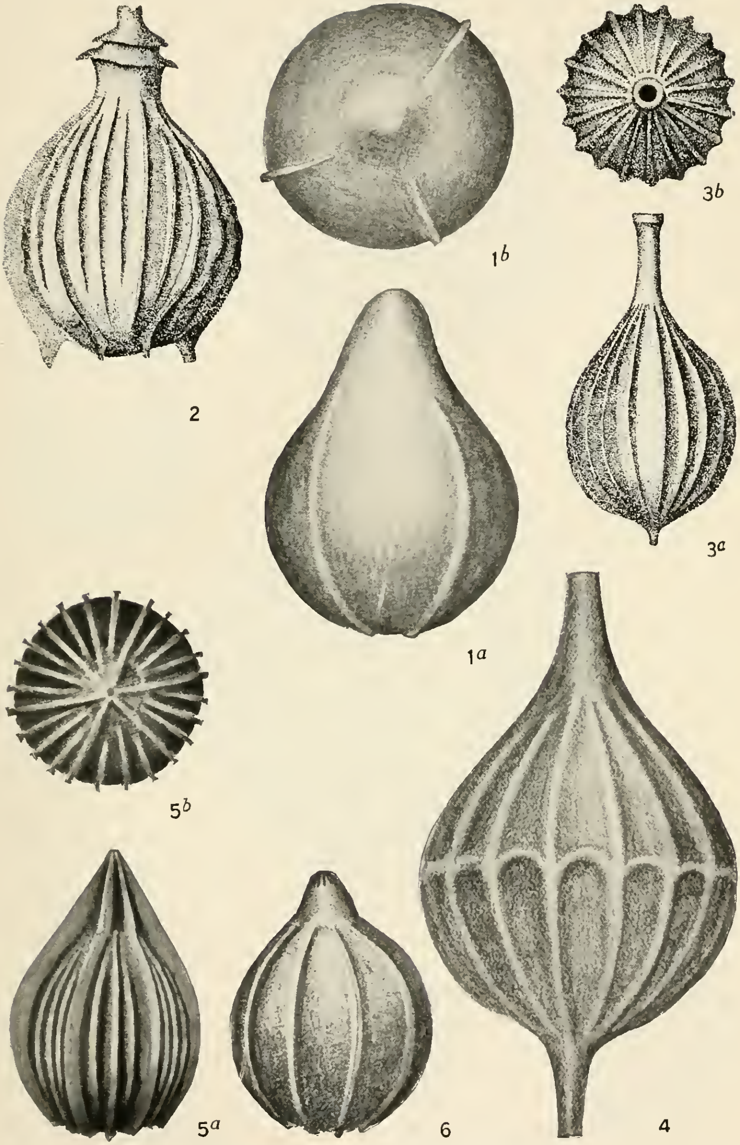
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 112.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5a
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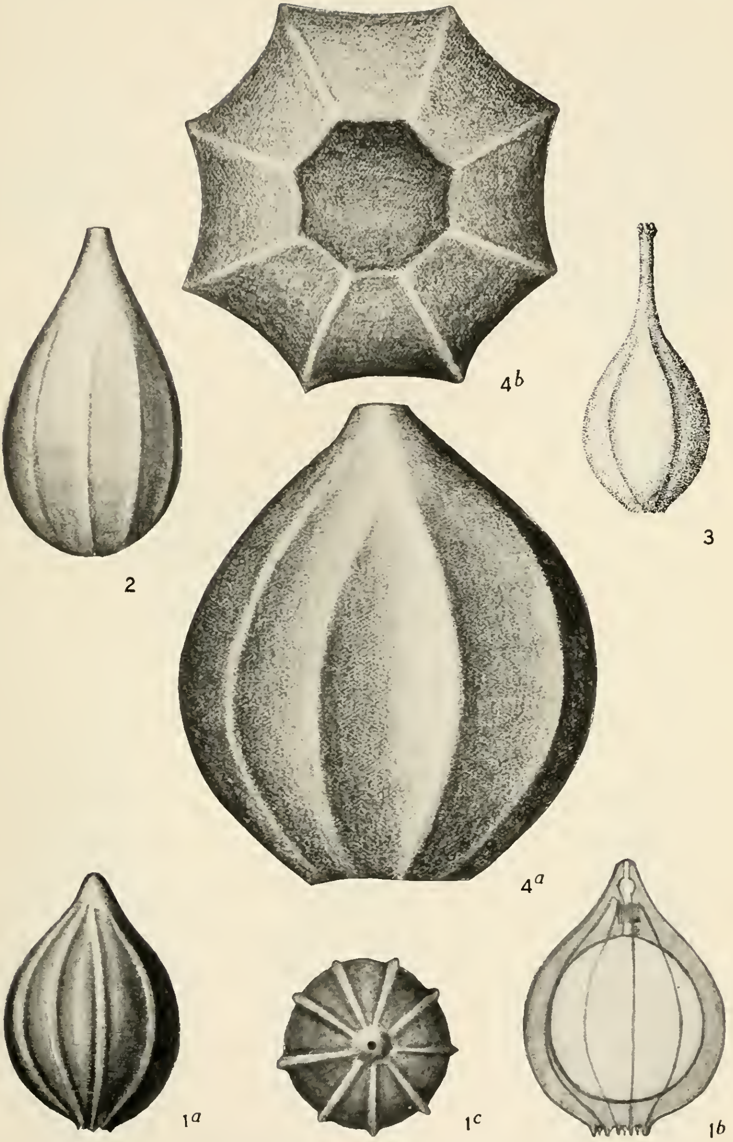
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 112.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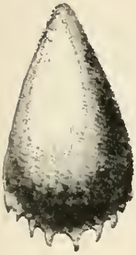
1c
1b

Lagenidæ of North Pacific Ocean.

For explanation of plate see page 112.



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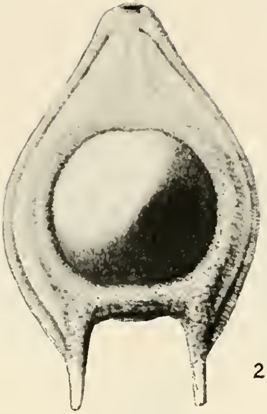

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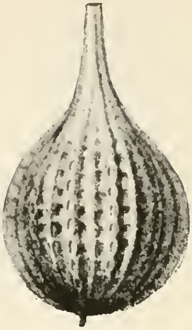

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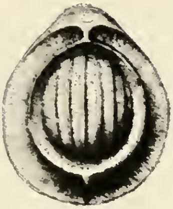

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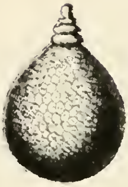

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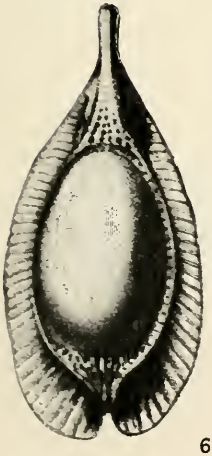

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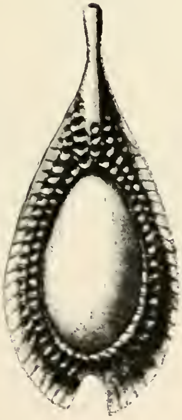

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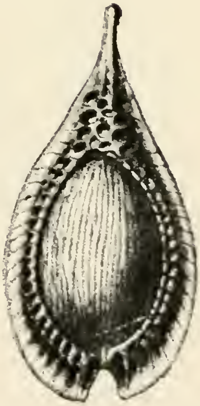

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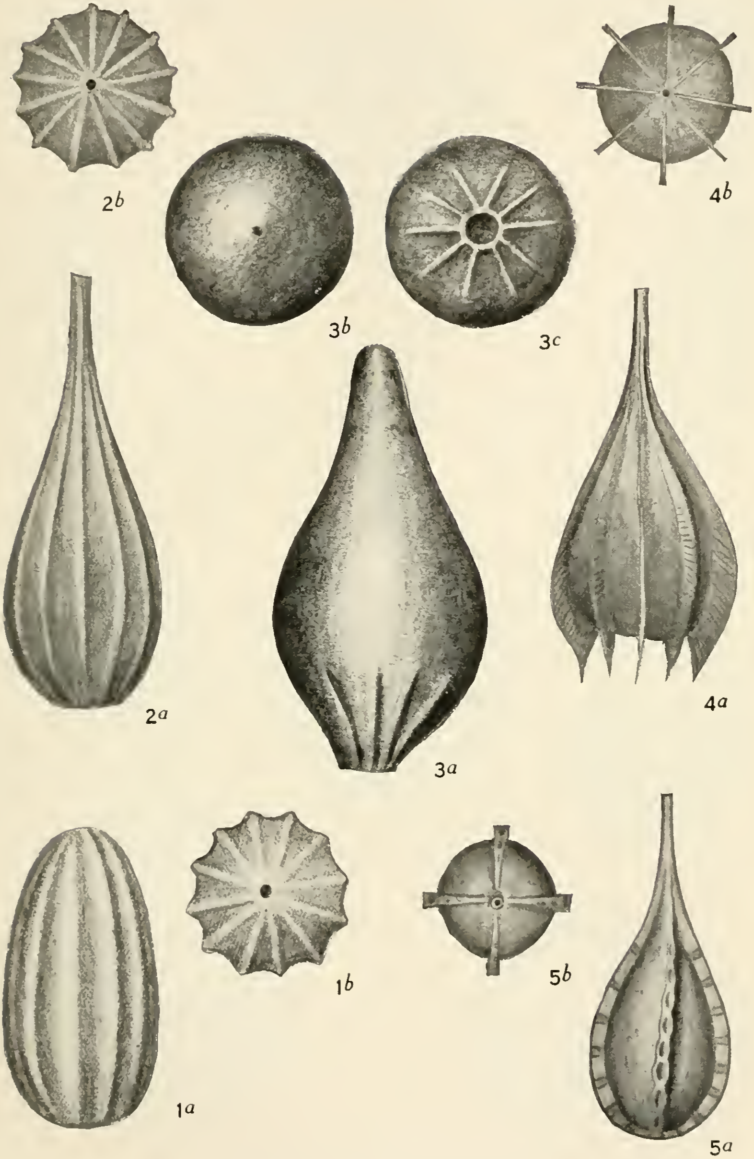
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 112.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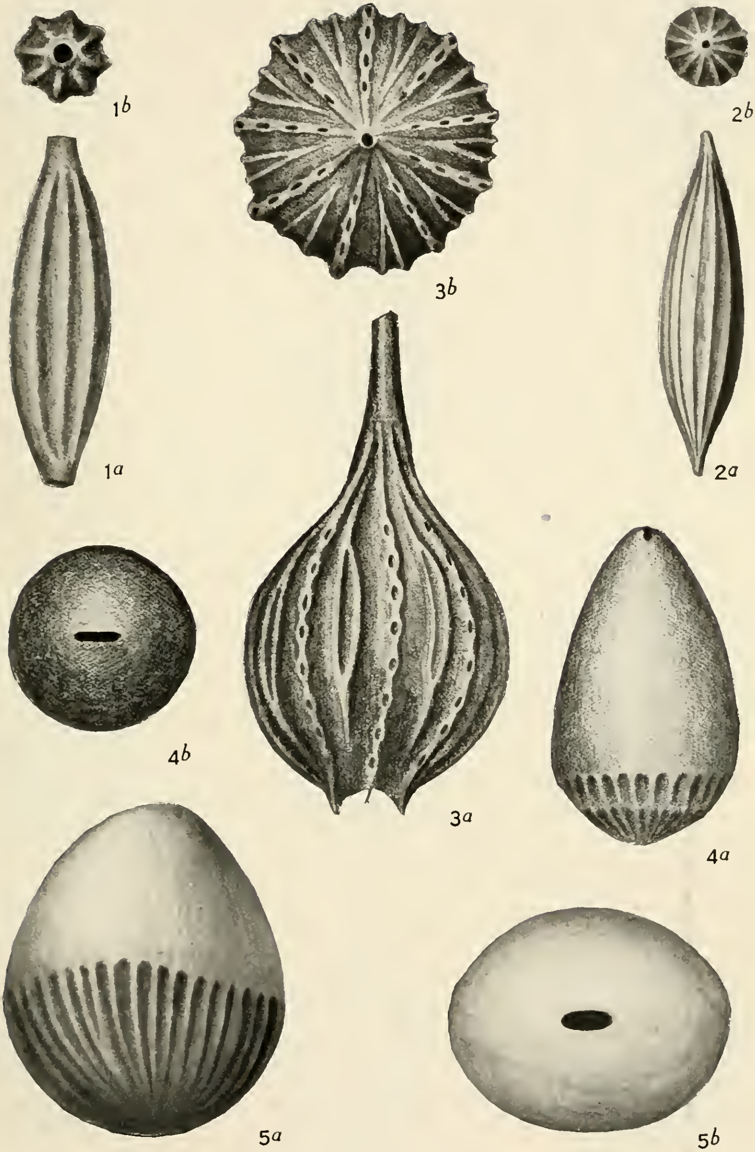
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 113.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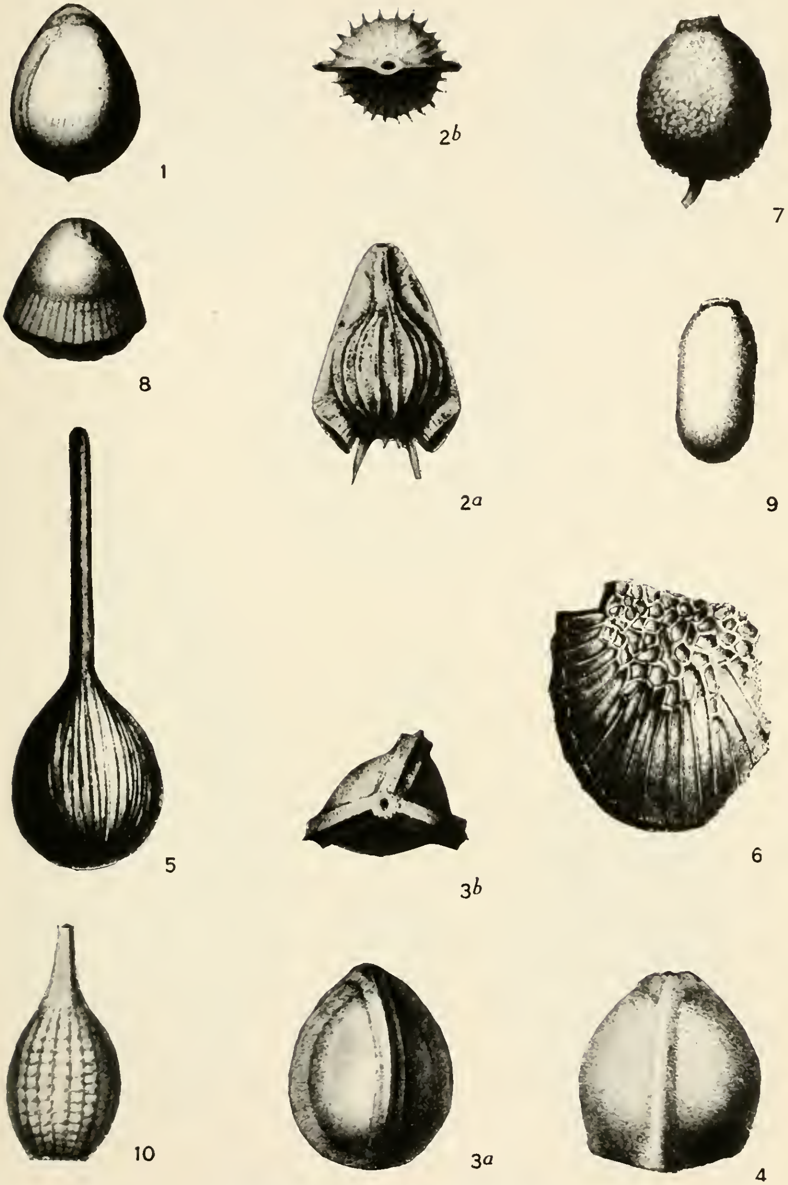
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 113.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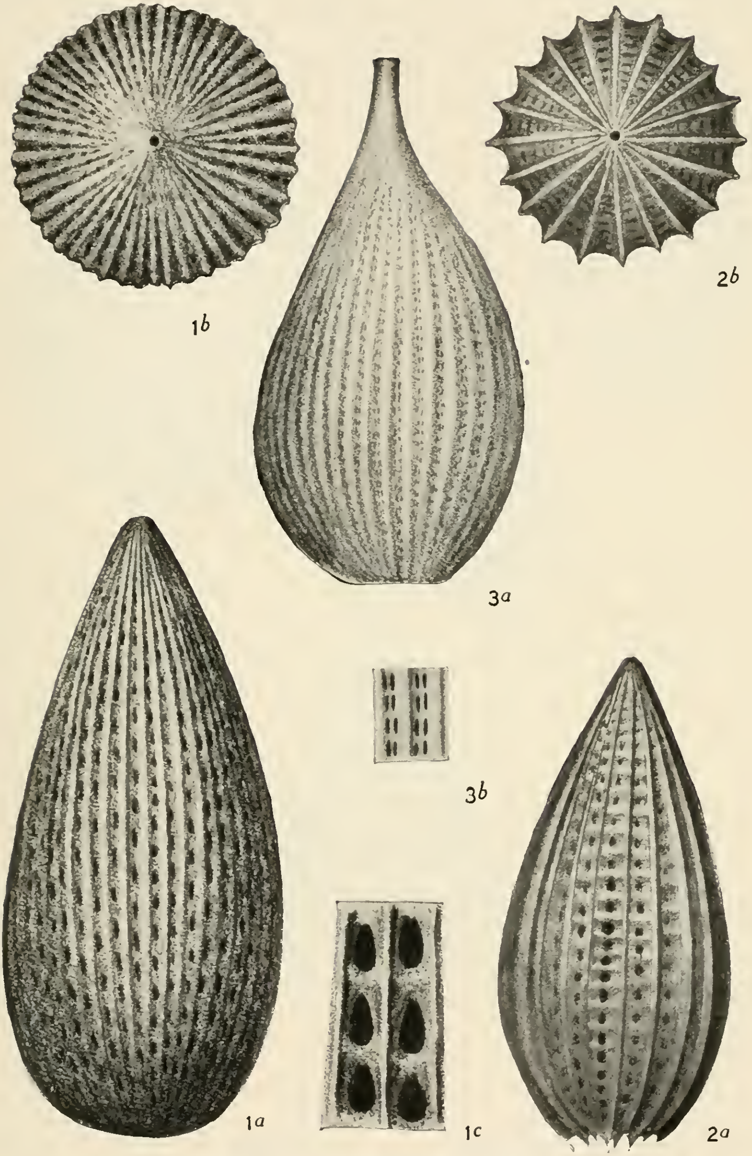
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 113.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LAGENIDÆ OF NORTH PACIFIC OCEAN.

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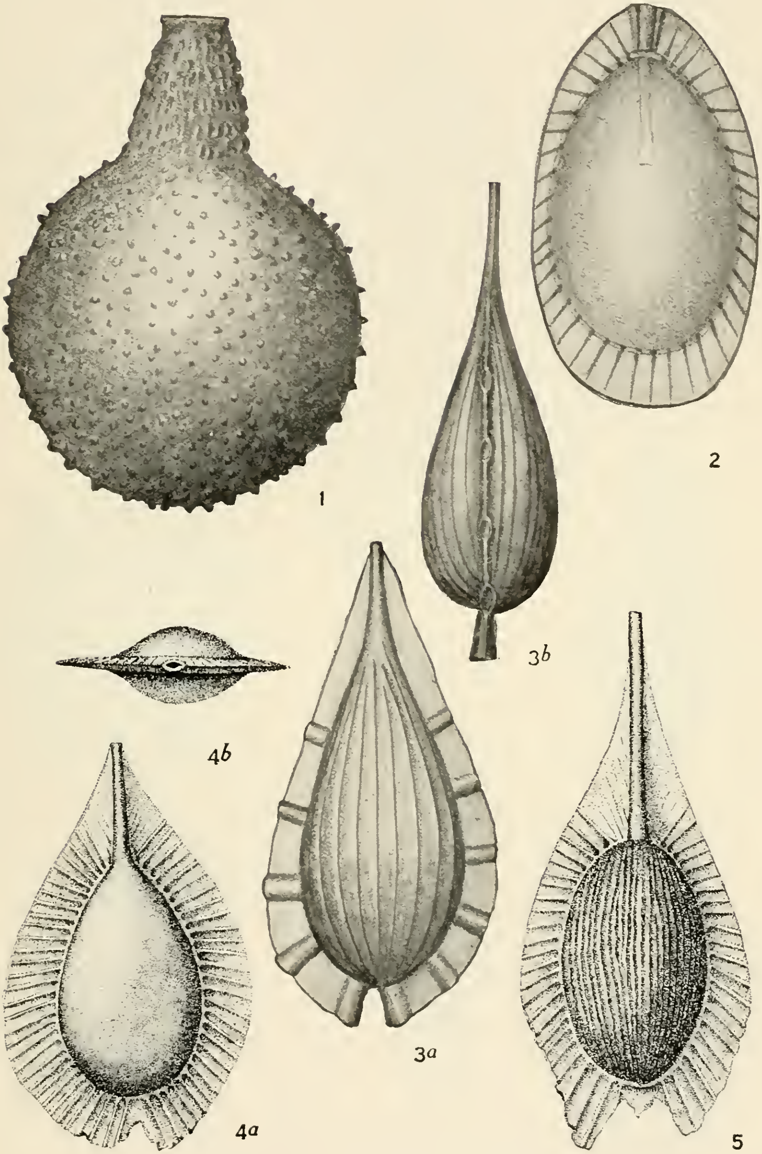
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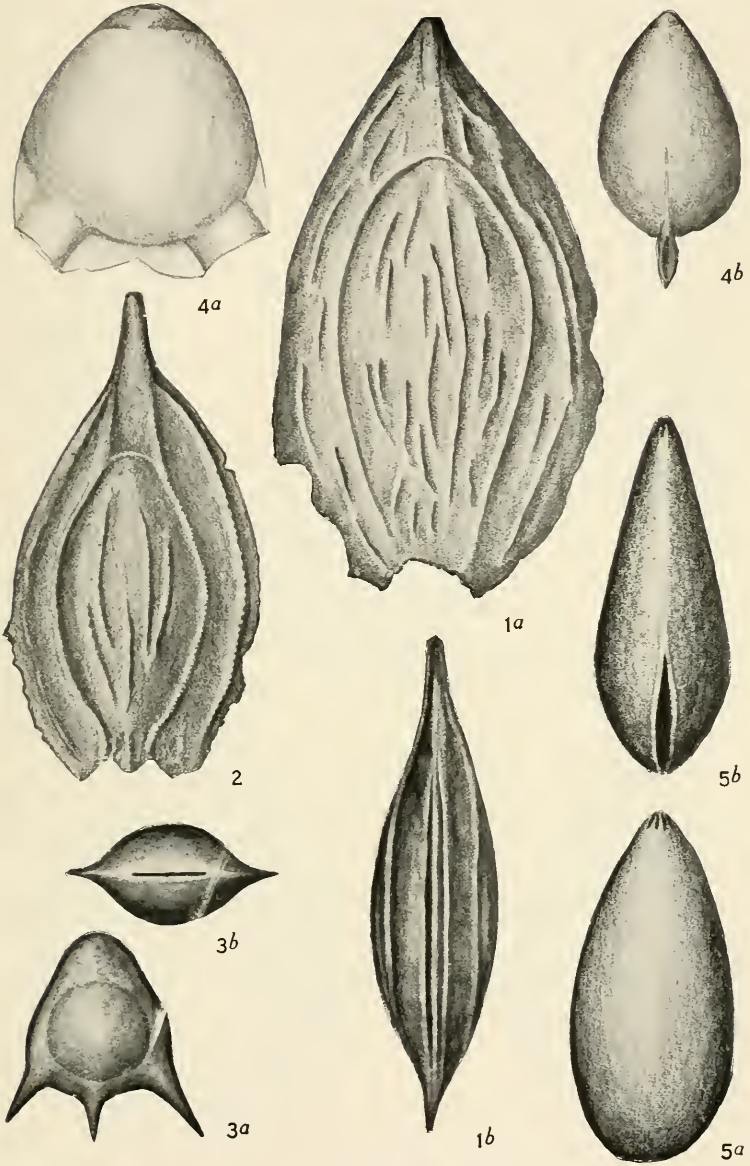
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 113.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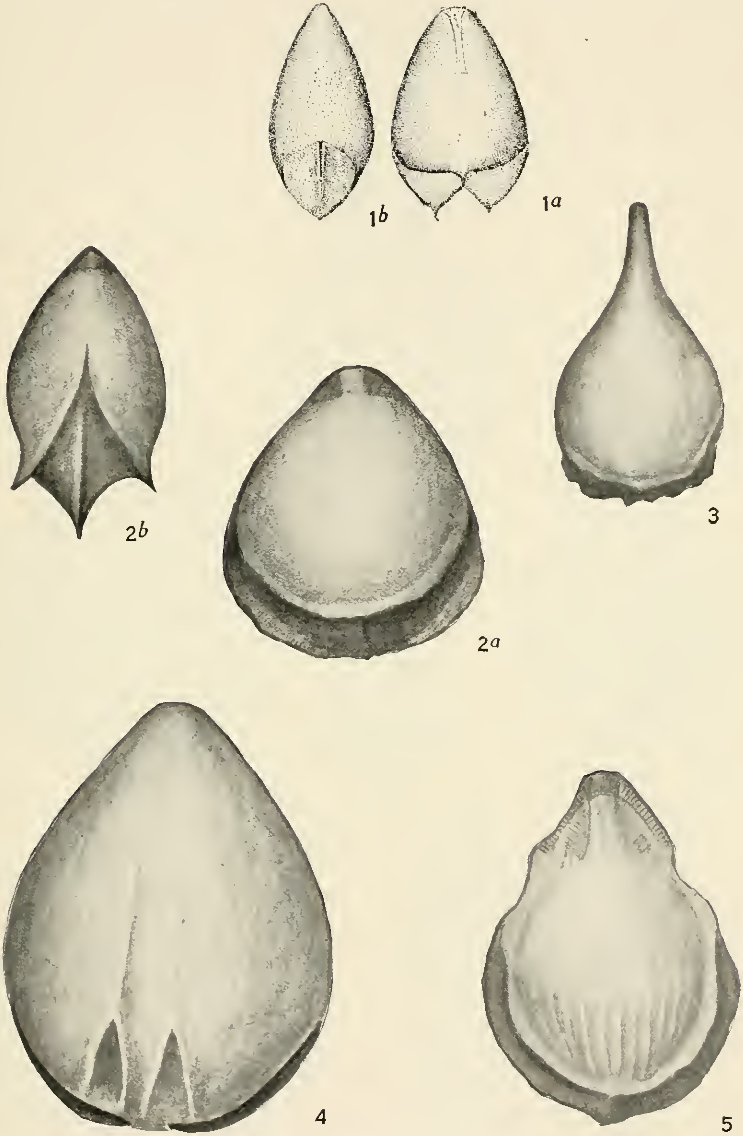
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 113.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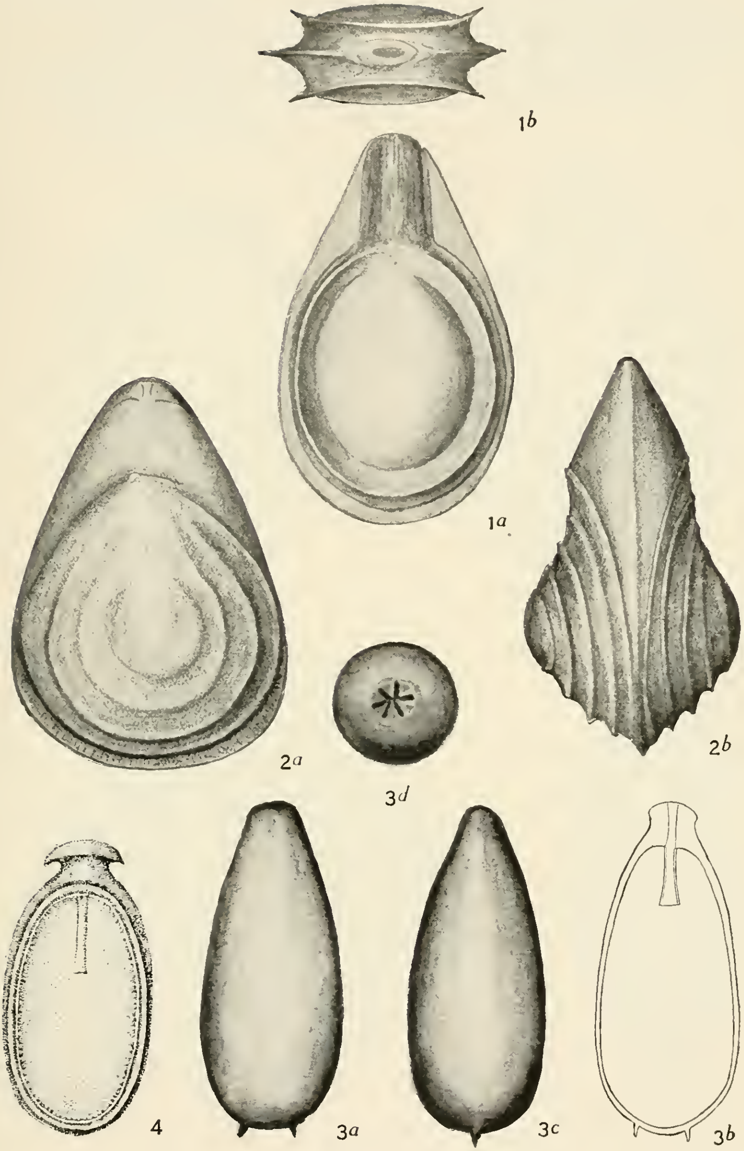
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 113.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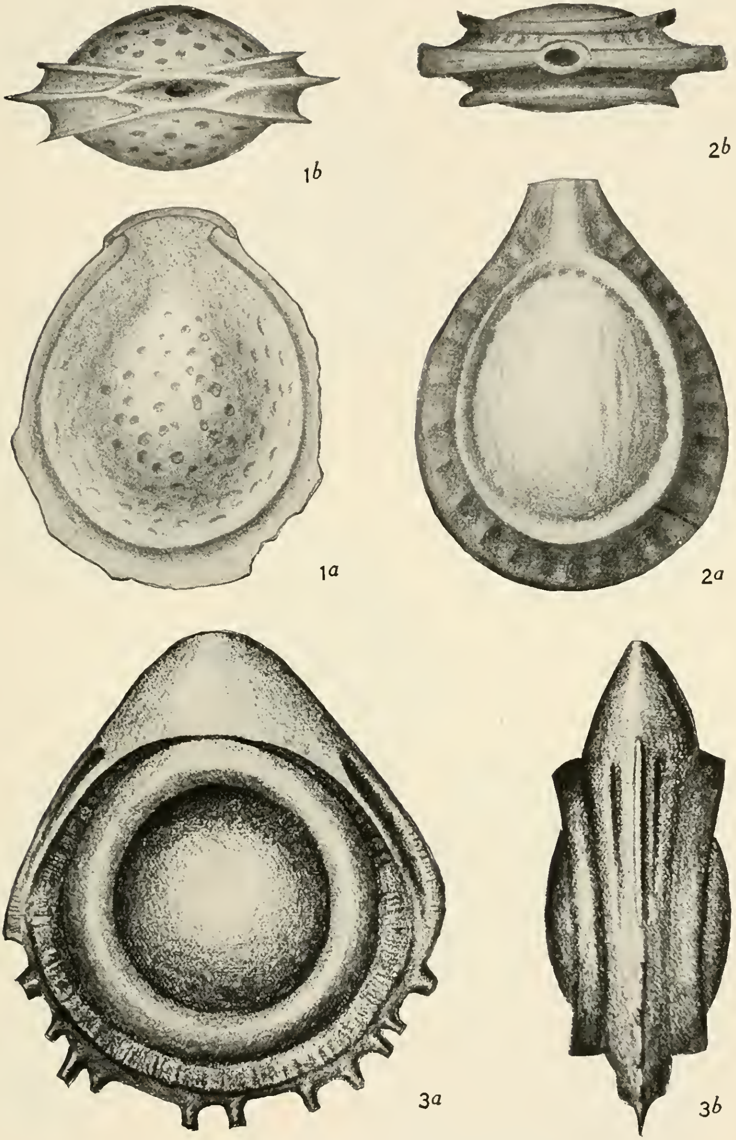
3b

LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 114.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3a
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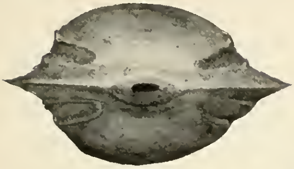
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 114.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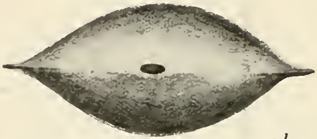
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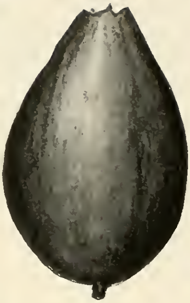
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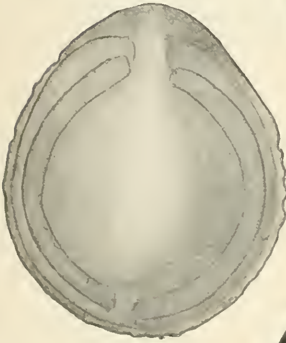
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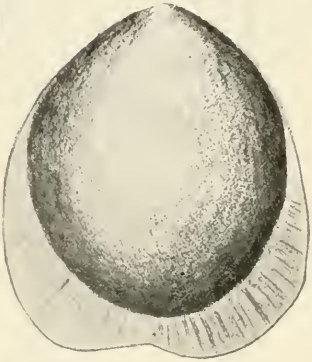
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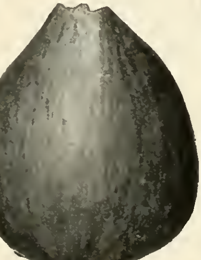
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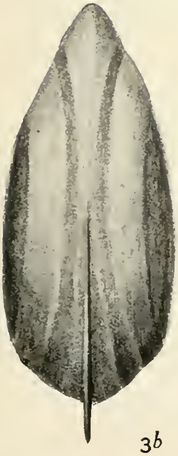
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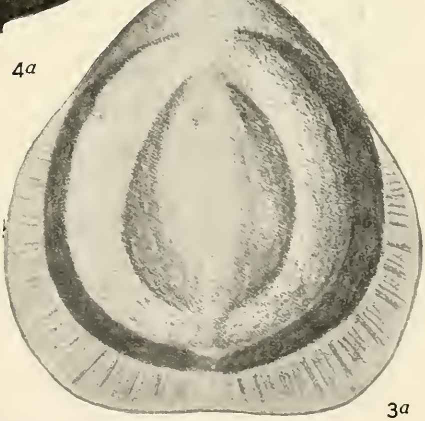
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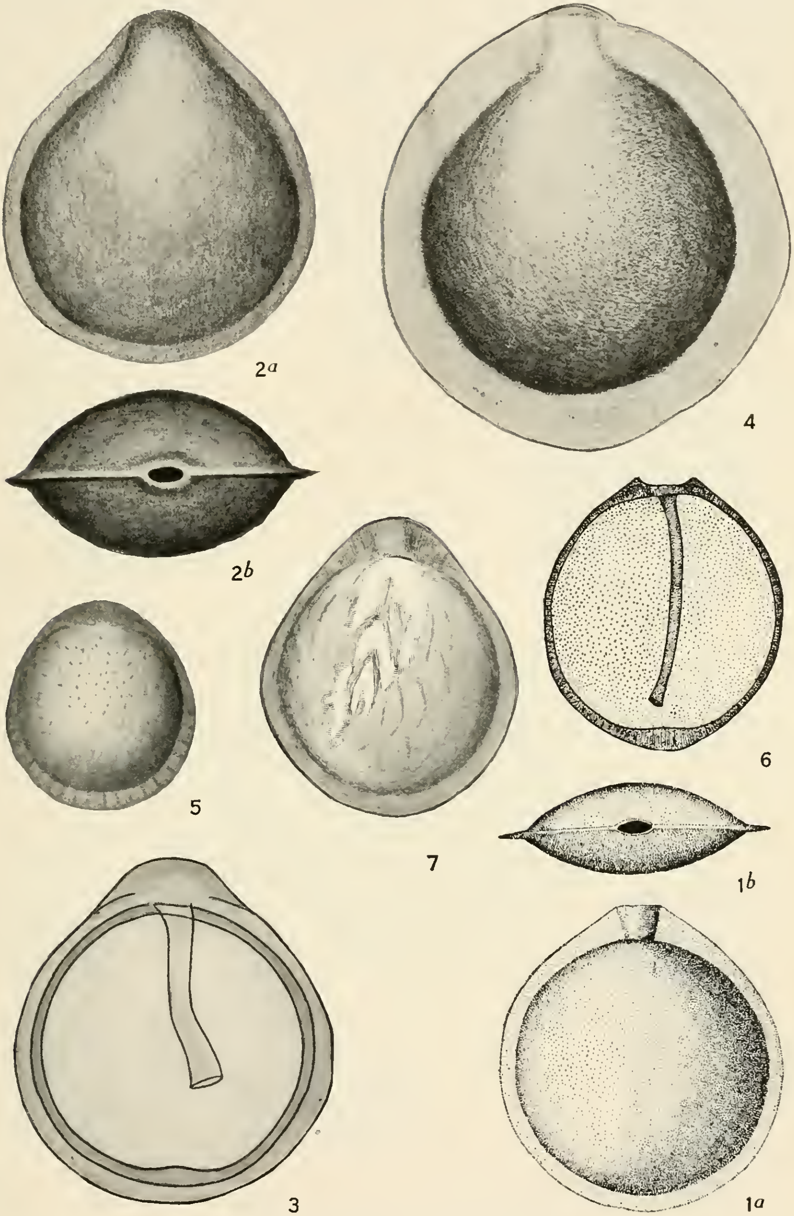
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 114.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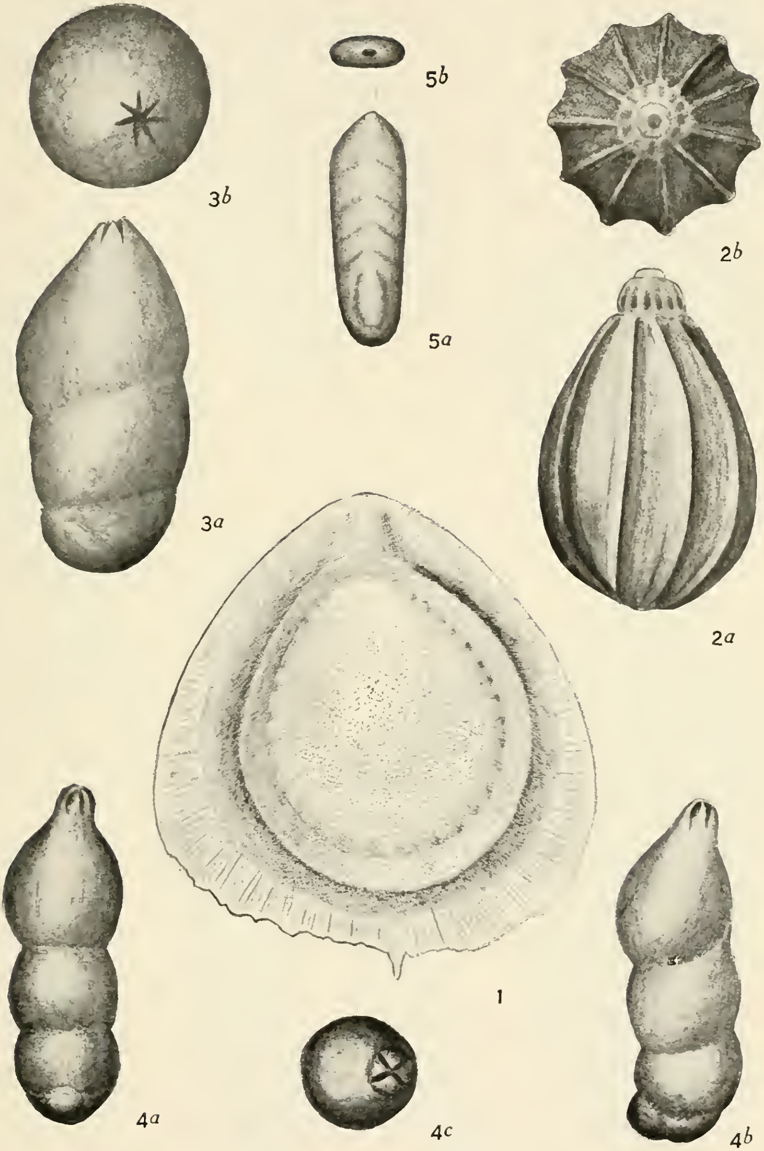
5
7
1b
3
1a

Lagenidæ of North Pacific Ocean.

For explanation of plate see page 114.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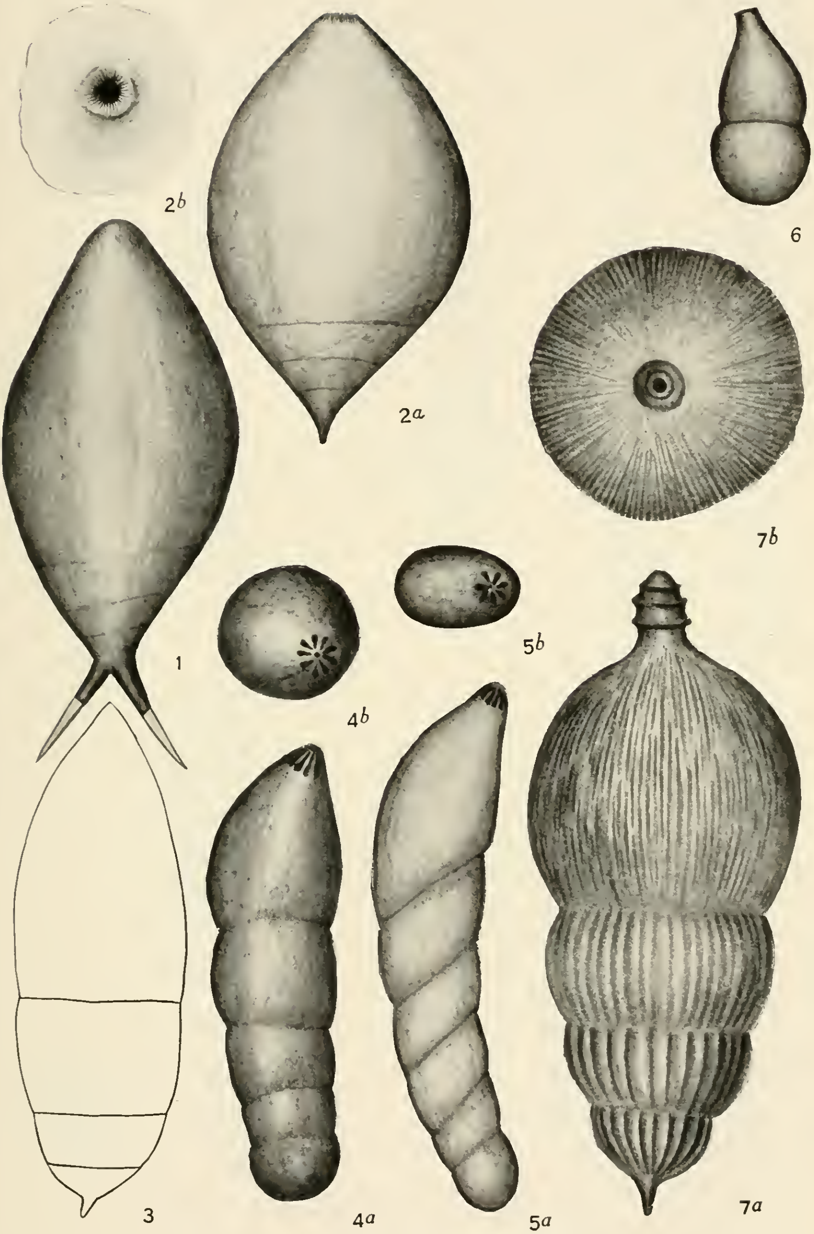
4b

Lagenidæ of North Pacific Ocean.

For explanation of plate see page 114.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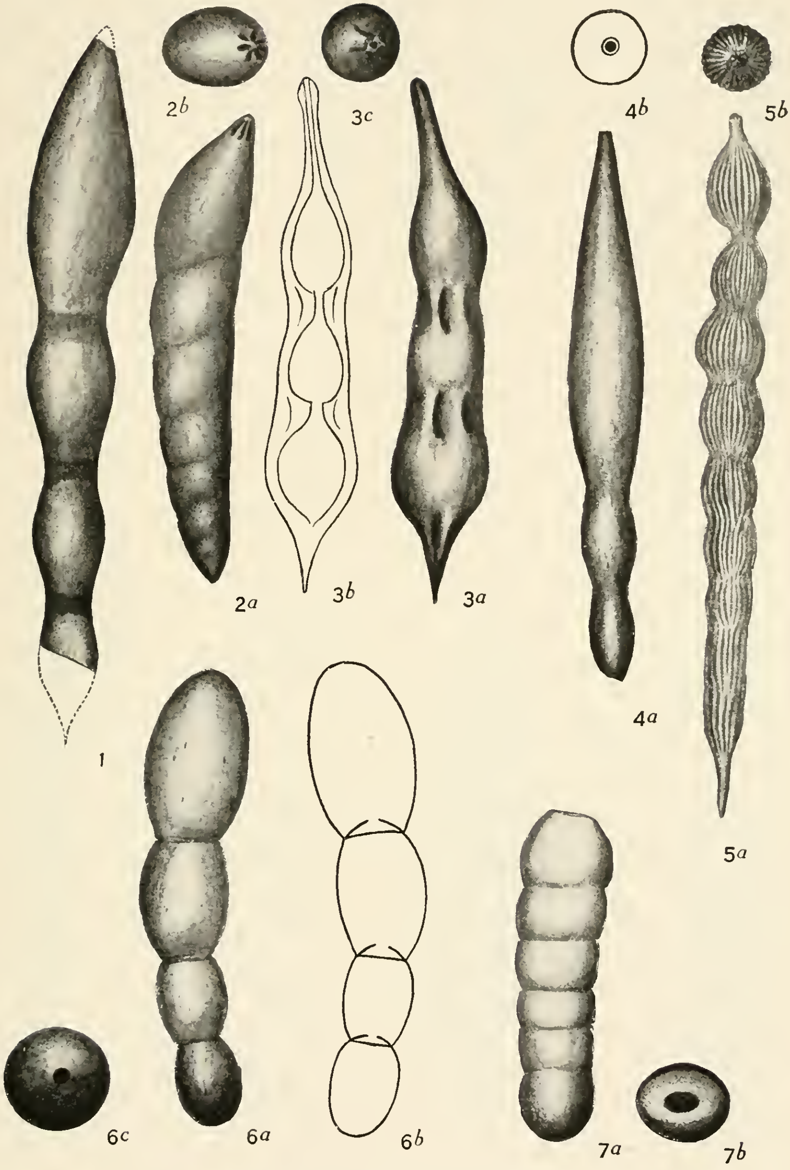
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 114.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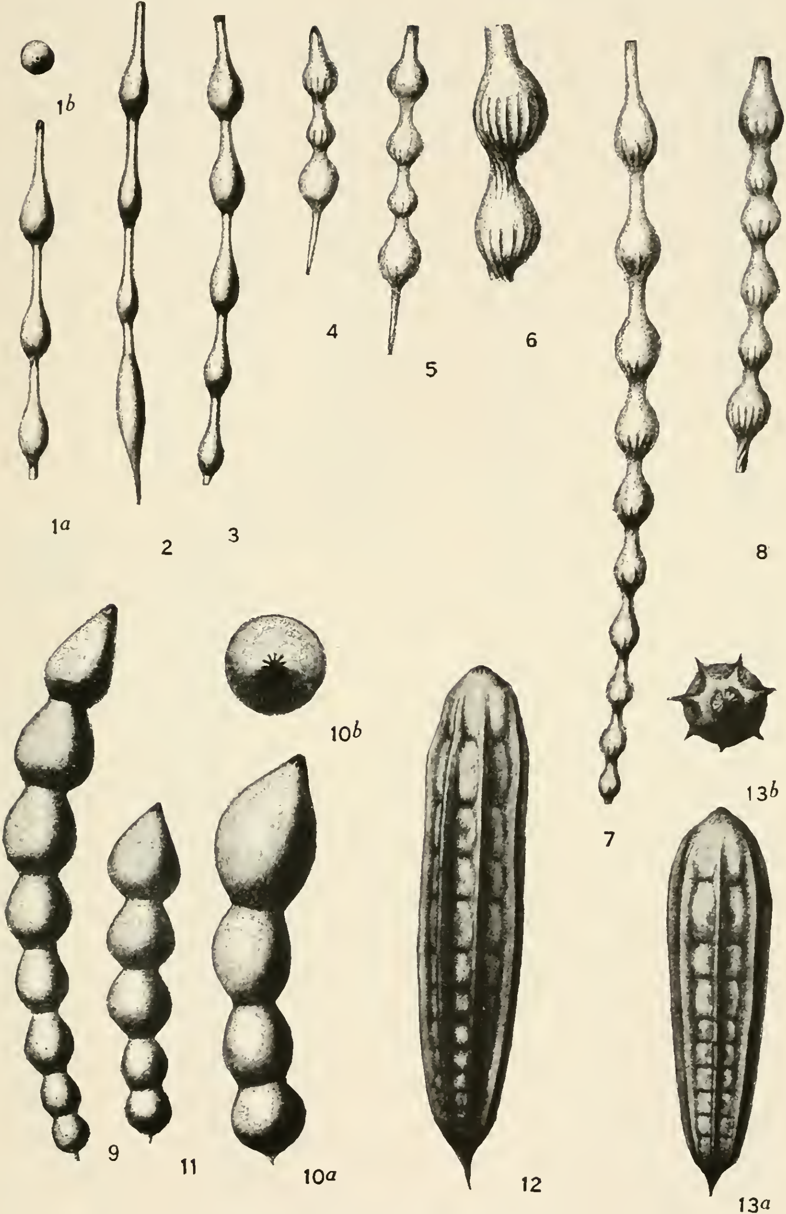
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 114.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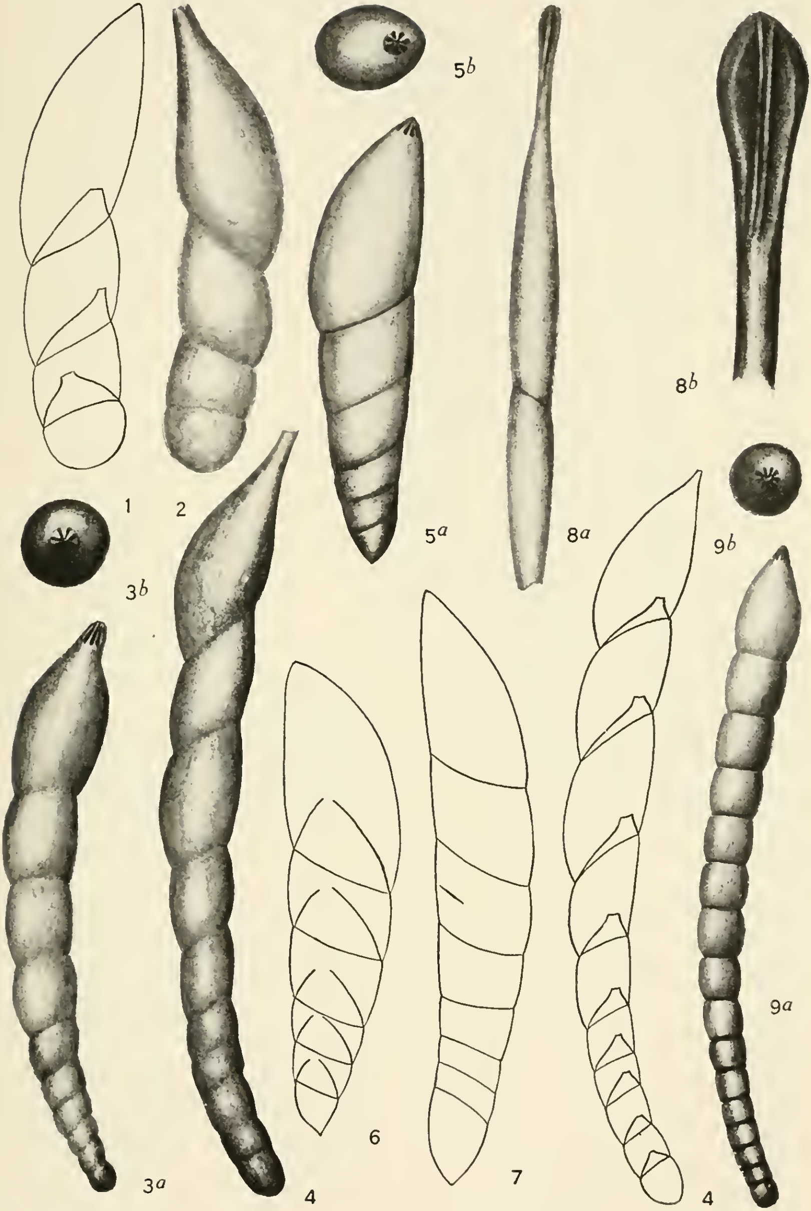
13a

LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 115.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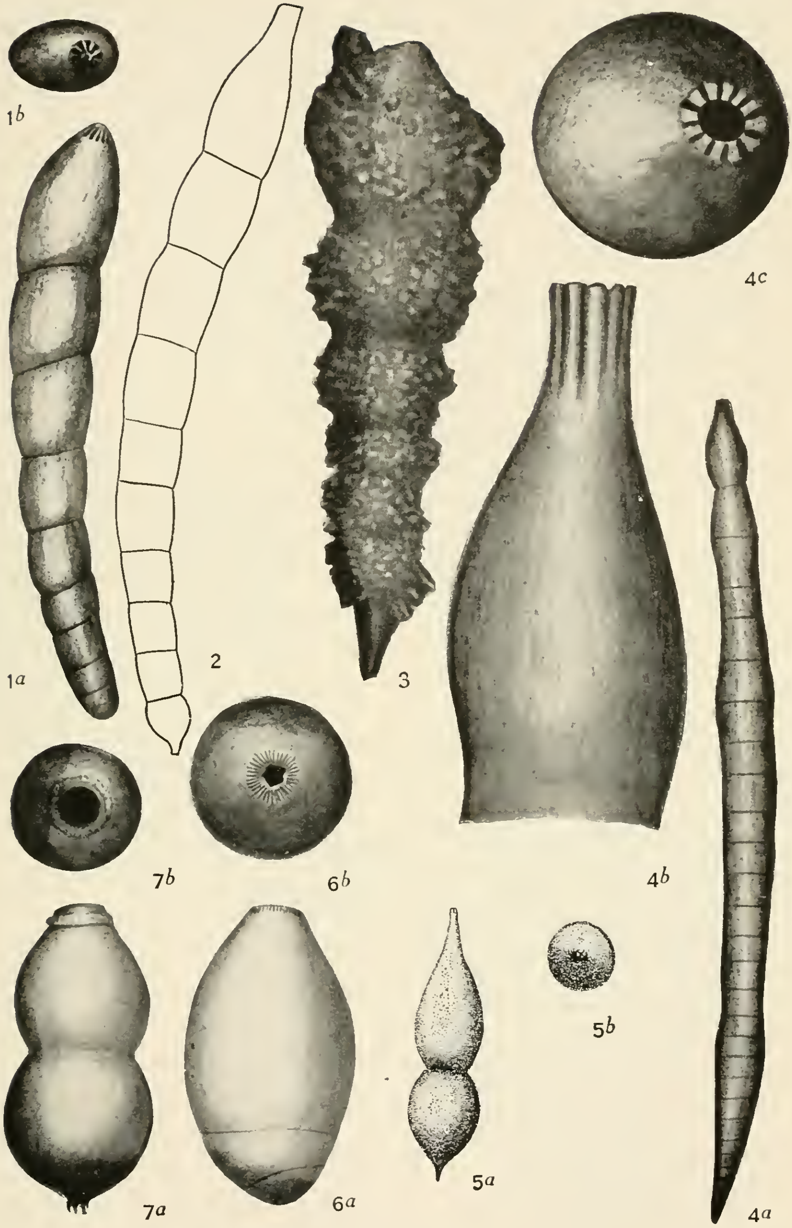
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 115.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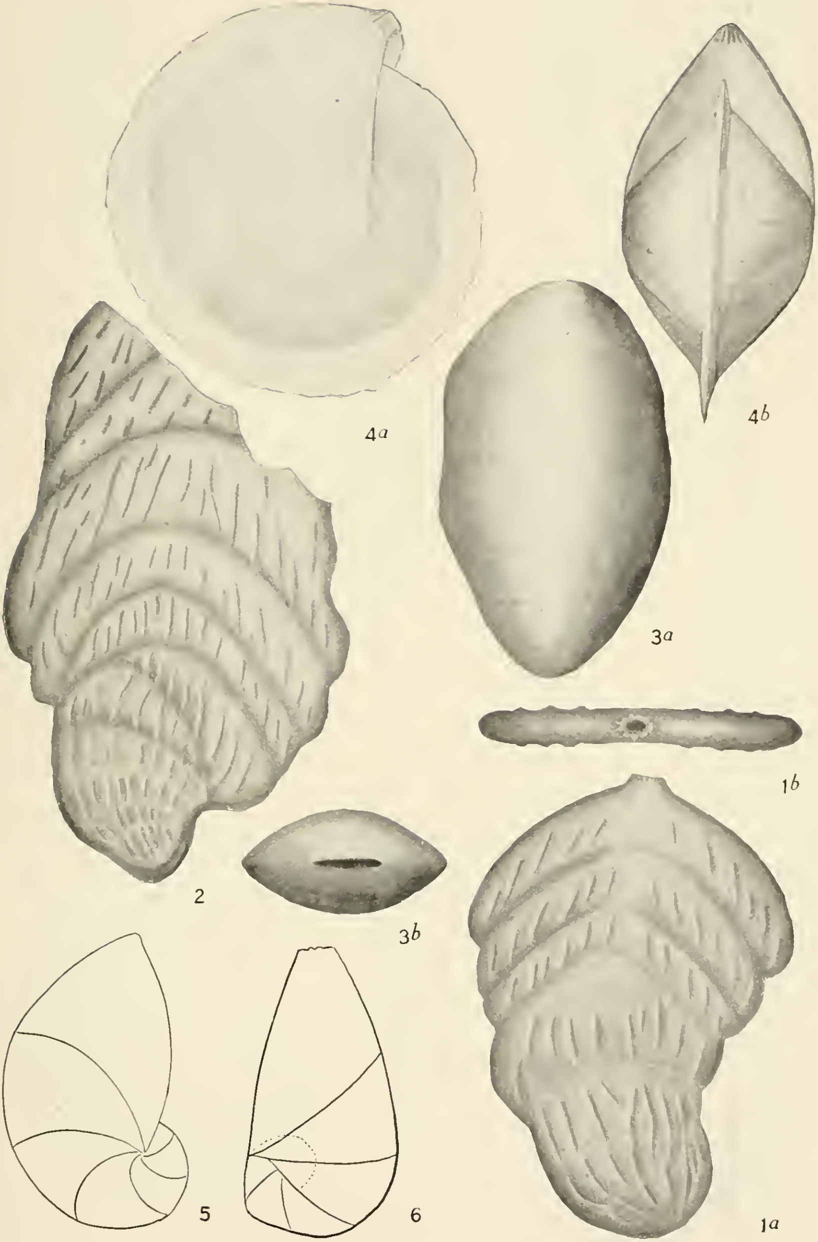
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 115.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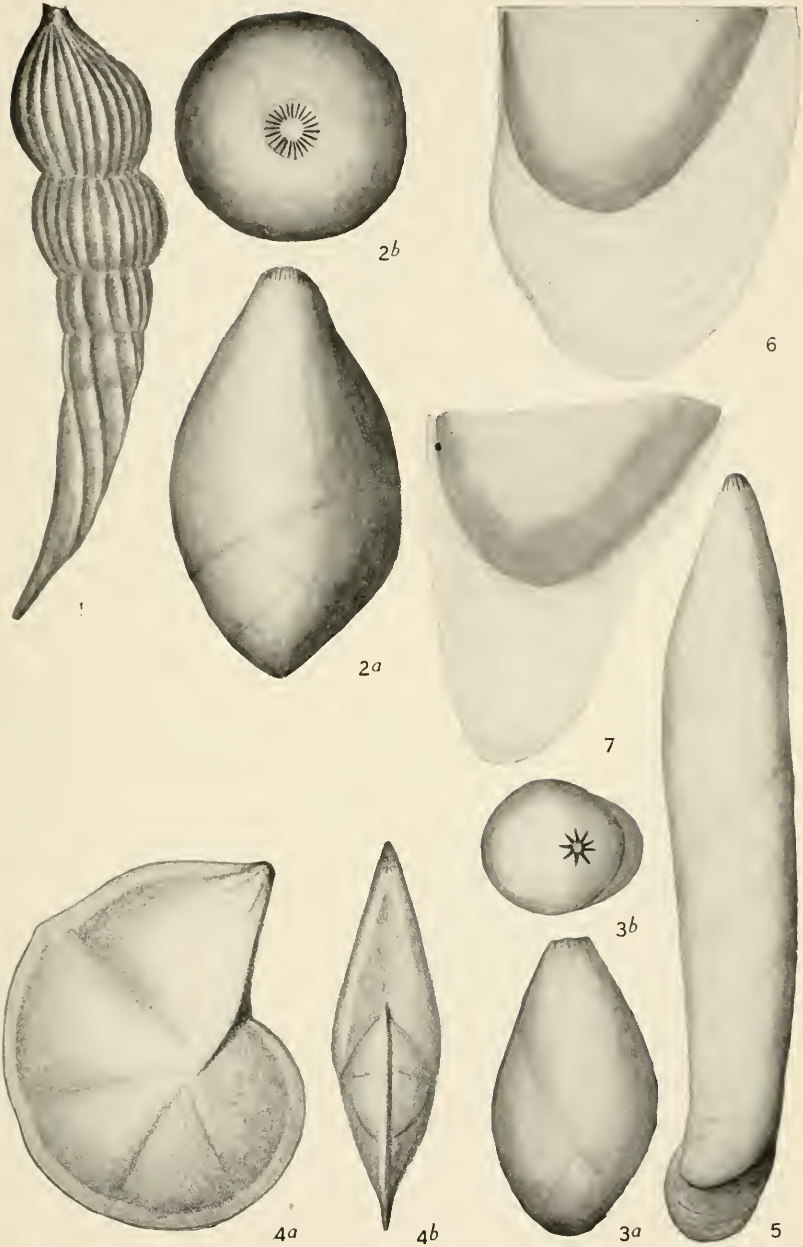
LAGENIDÆ OF NORTH PACIFIC OCEAN

FOR EXPLANATION OF PLATE SEE PAGE 115.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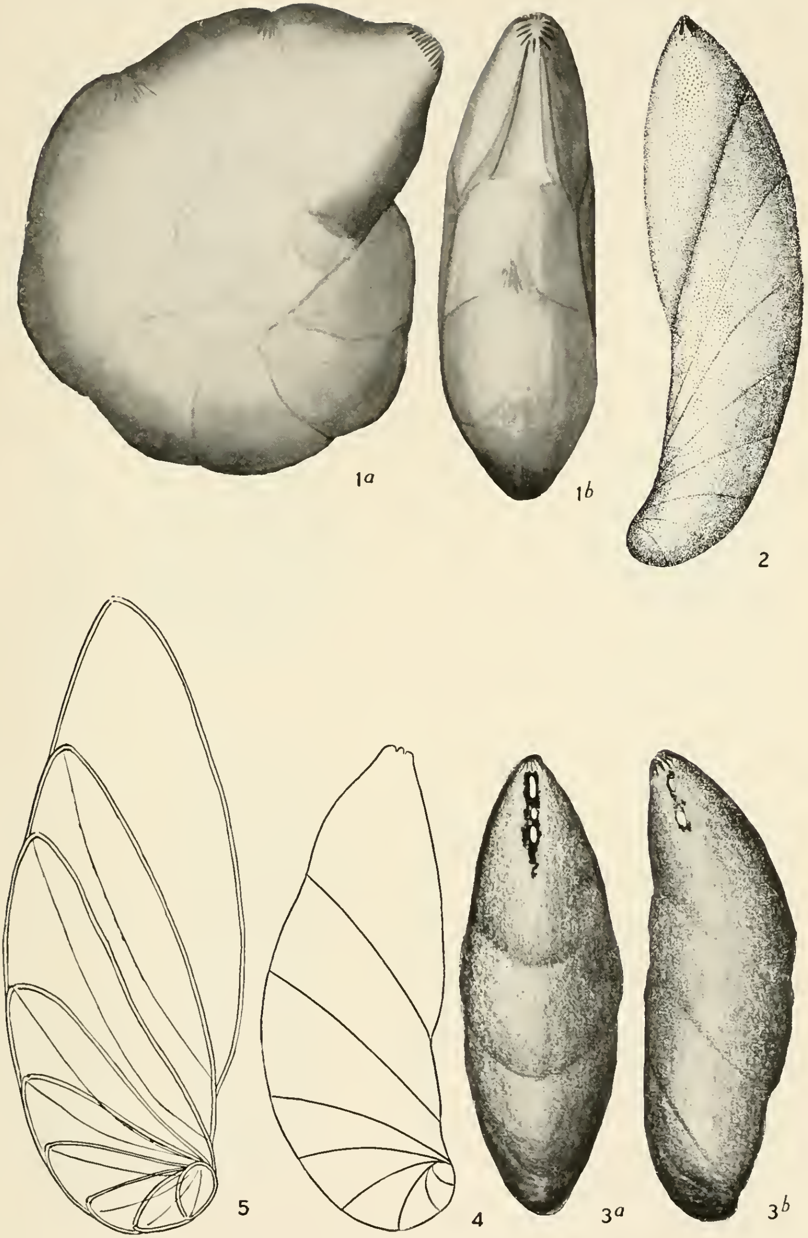
Lagenidæ of North Pacific Ocean.

For explanation of plate see page 115.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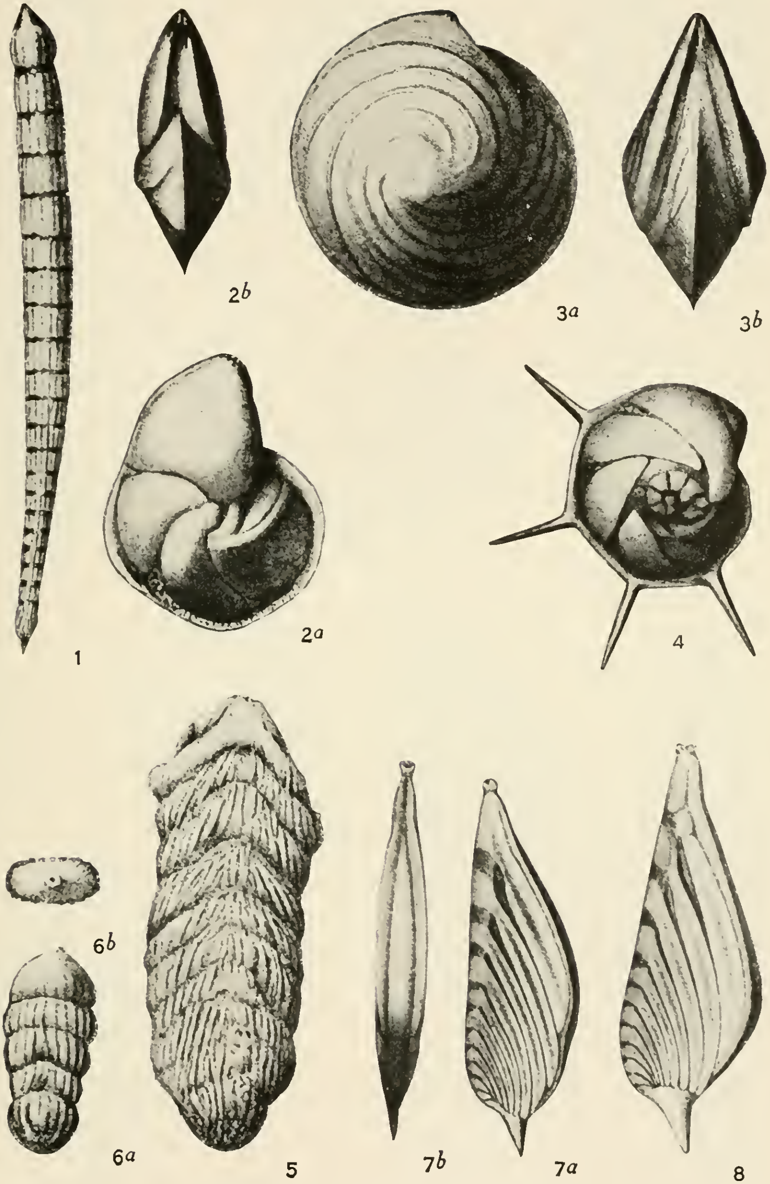
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 115.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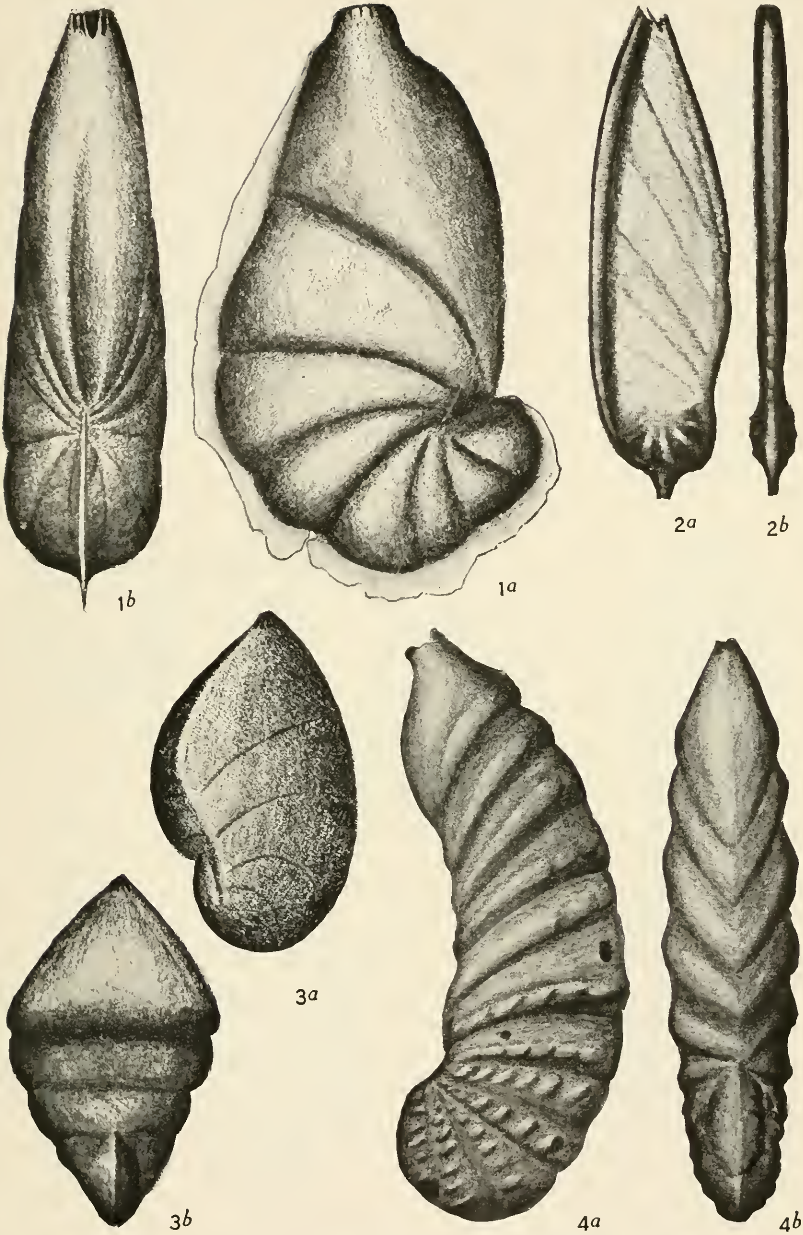
LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 116.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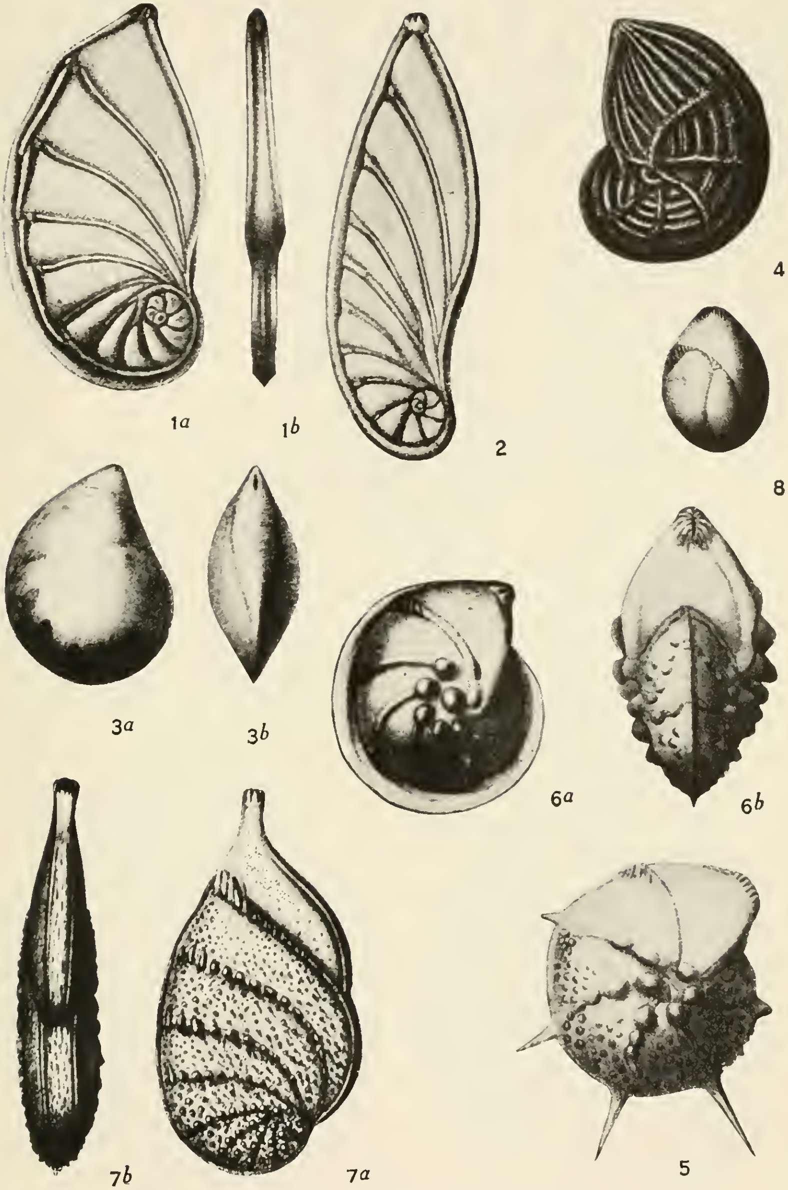
4b

LAGENIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 116.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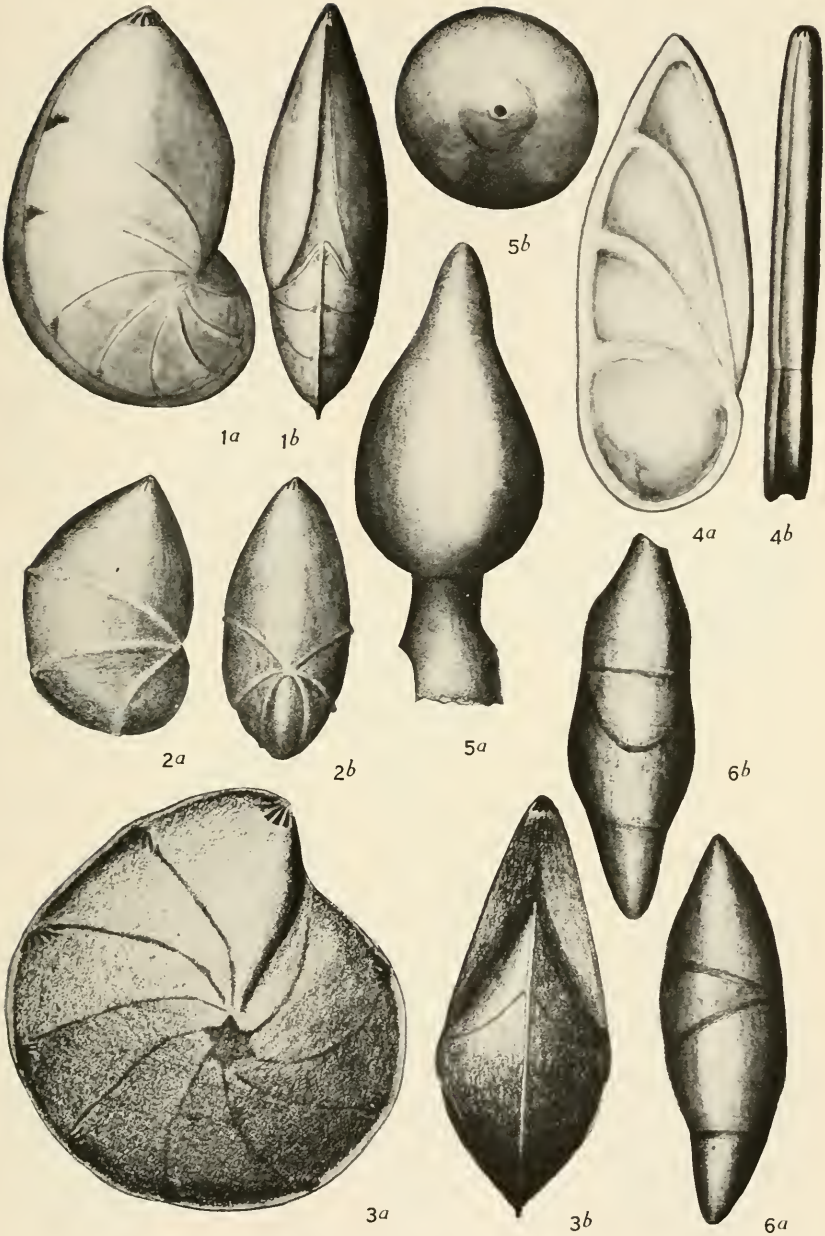
For explanation of plate see page 116.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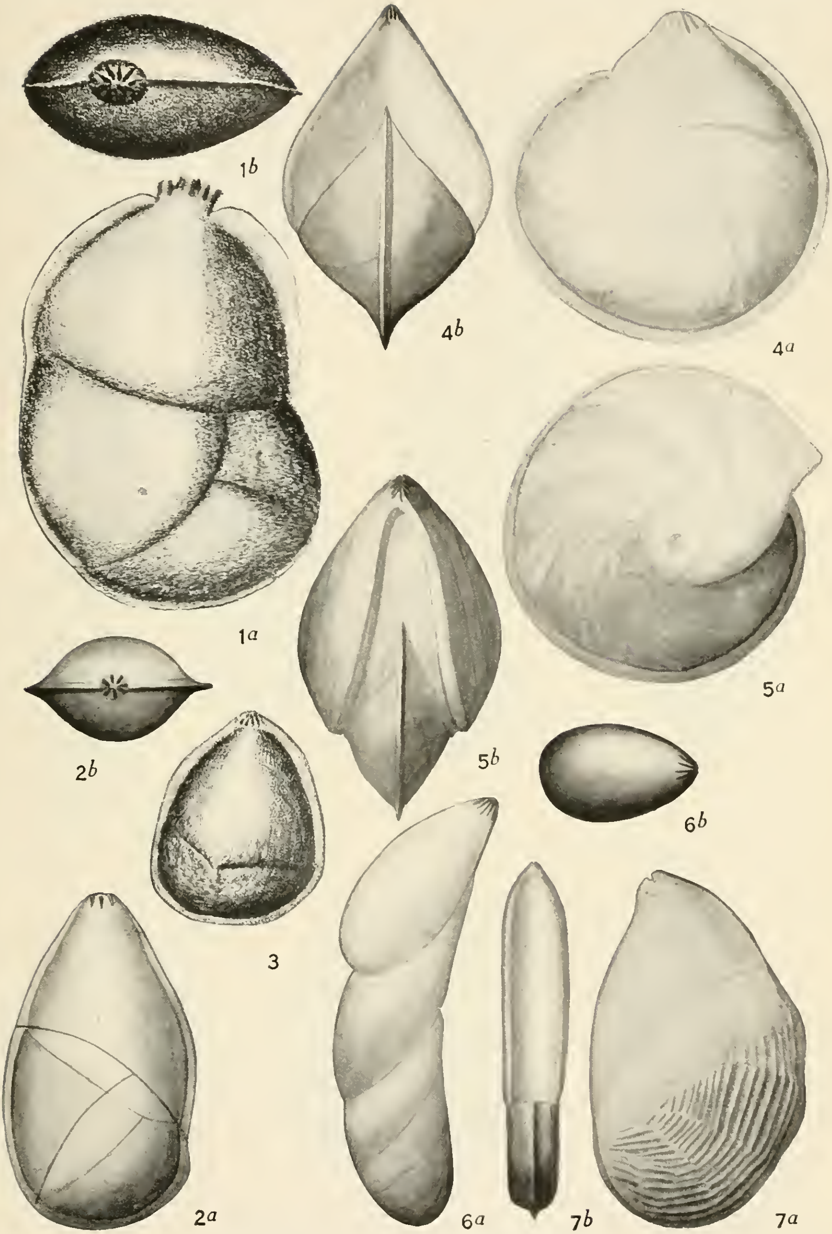
For explanation of plate see page 116.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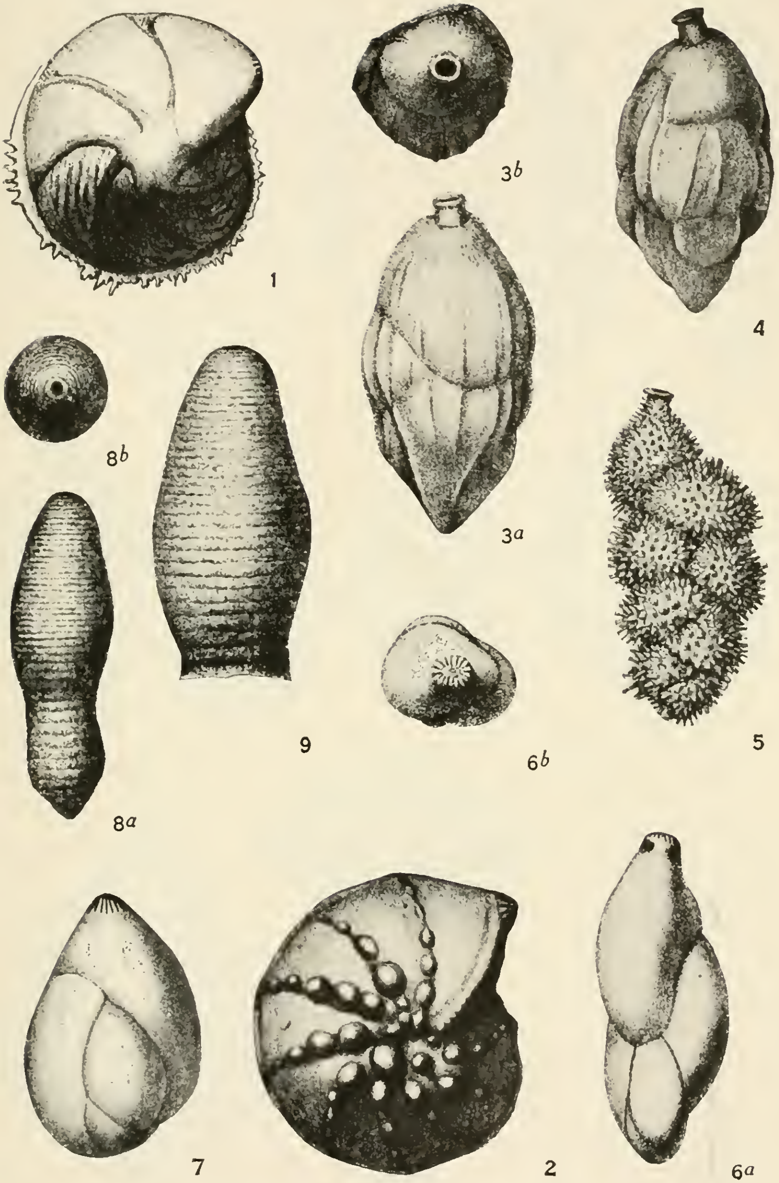
For explanation of plate see page 116.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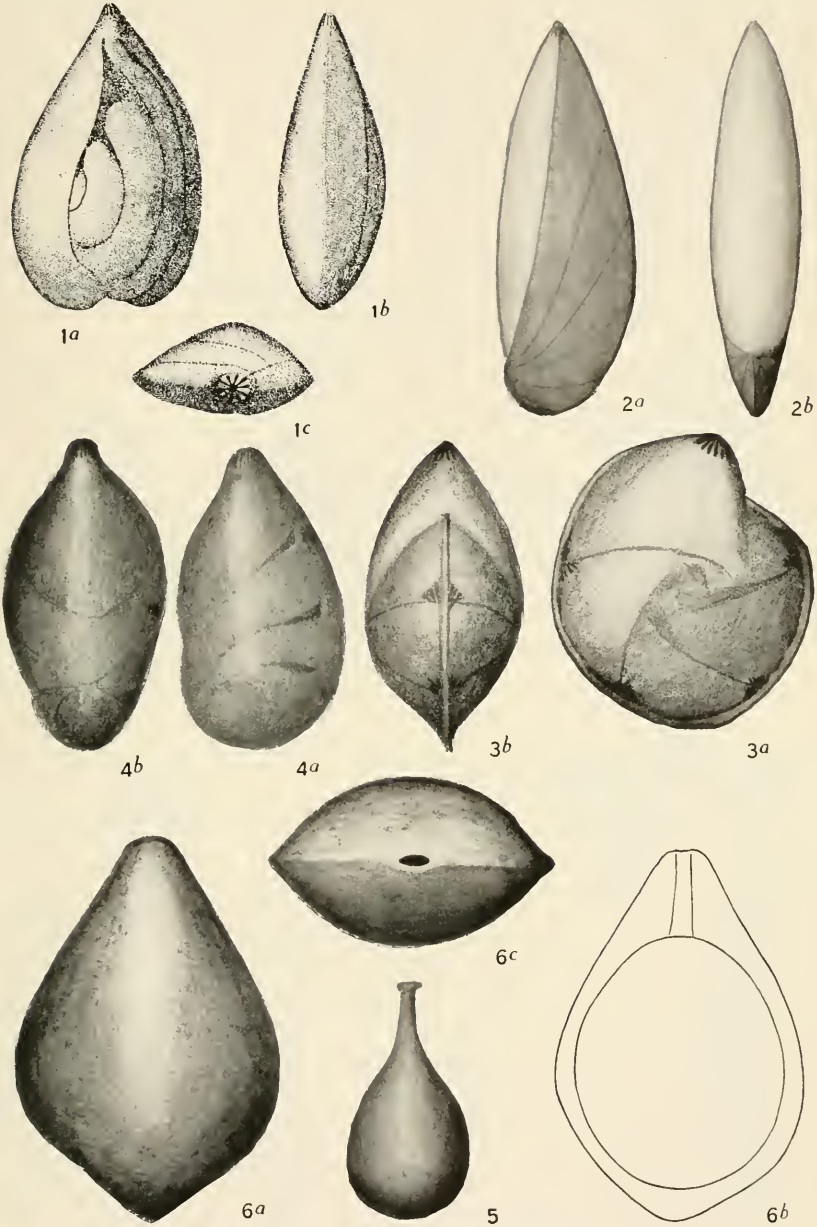
FOR EXPLANATION OF PLATE SEE PAGE 116.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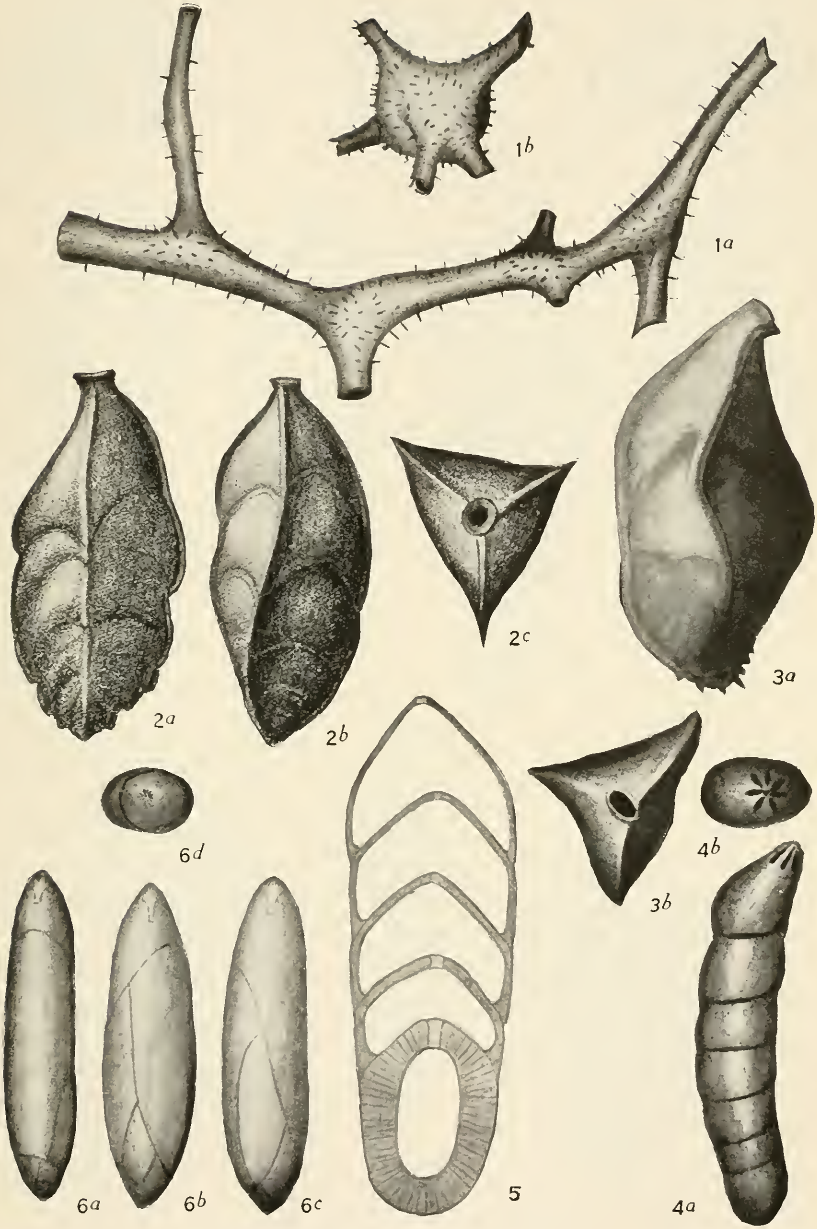
For explanation of plate see page 117.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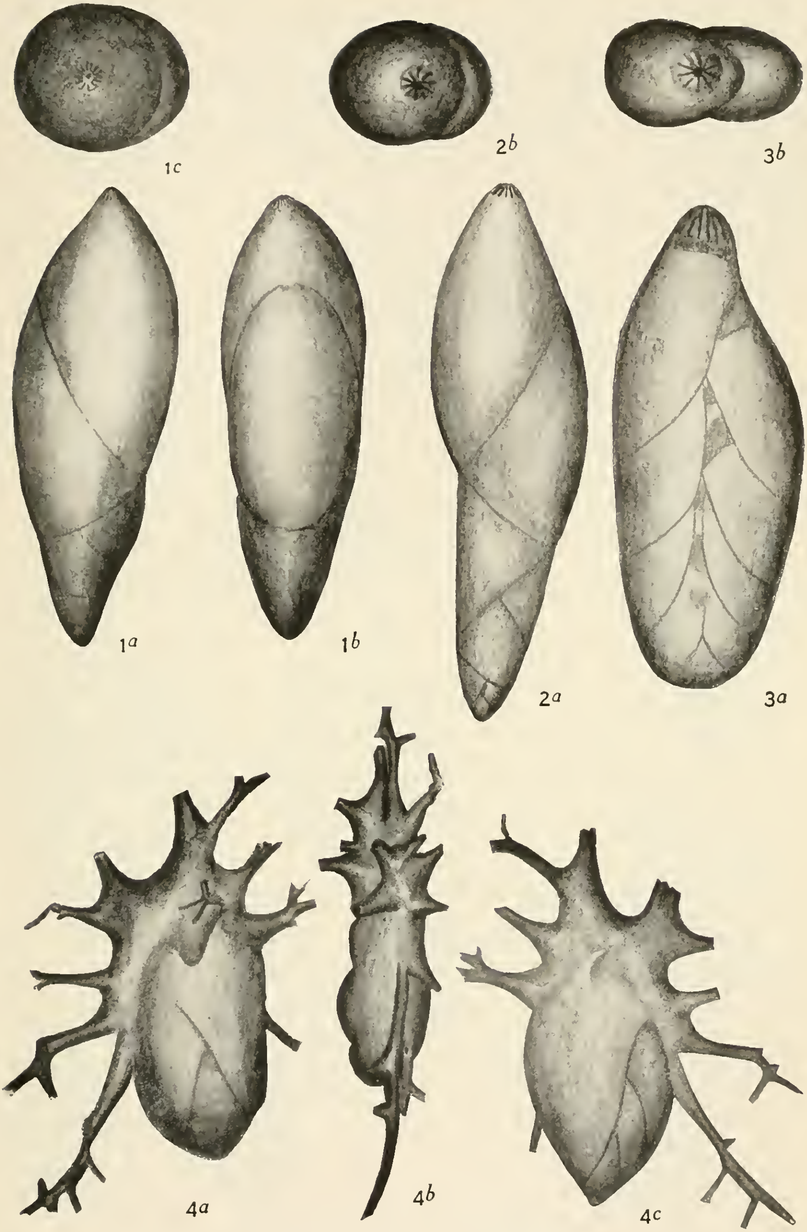
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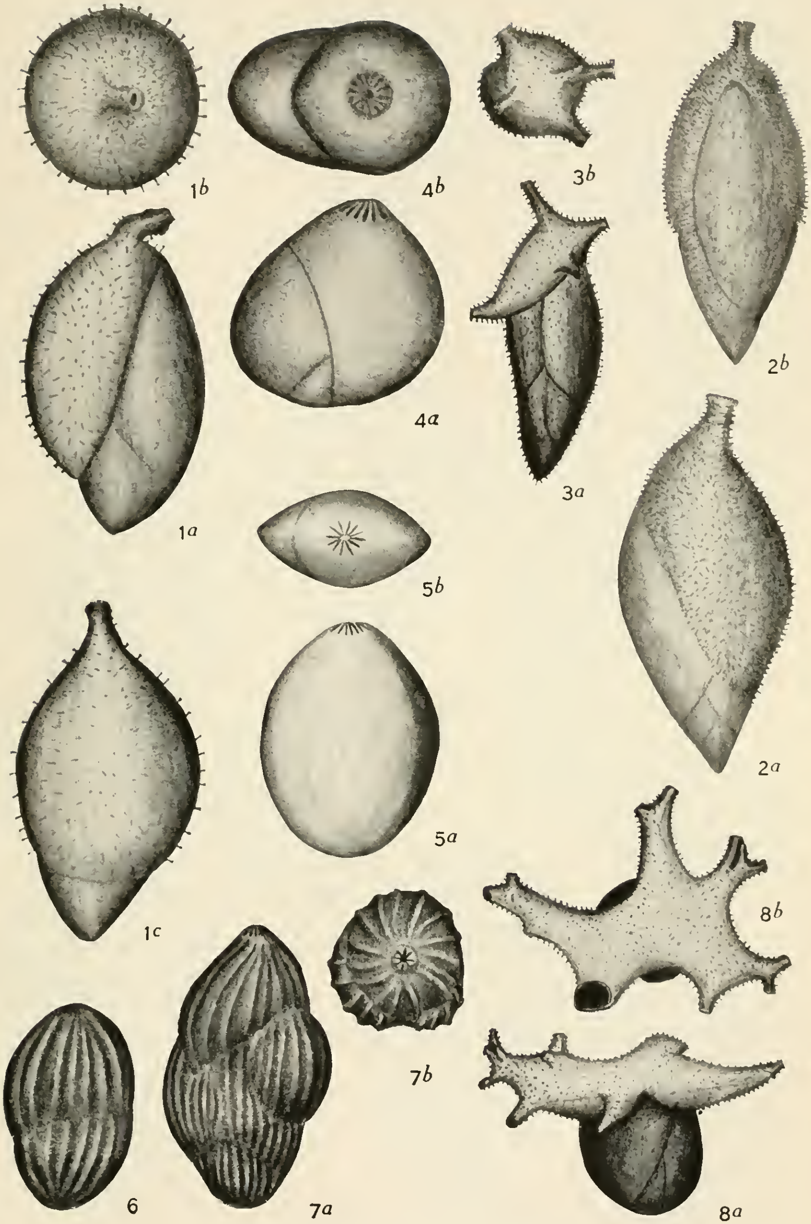
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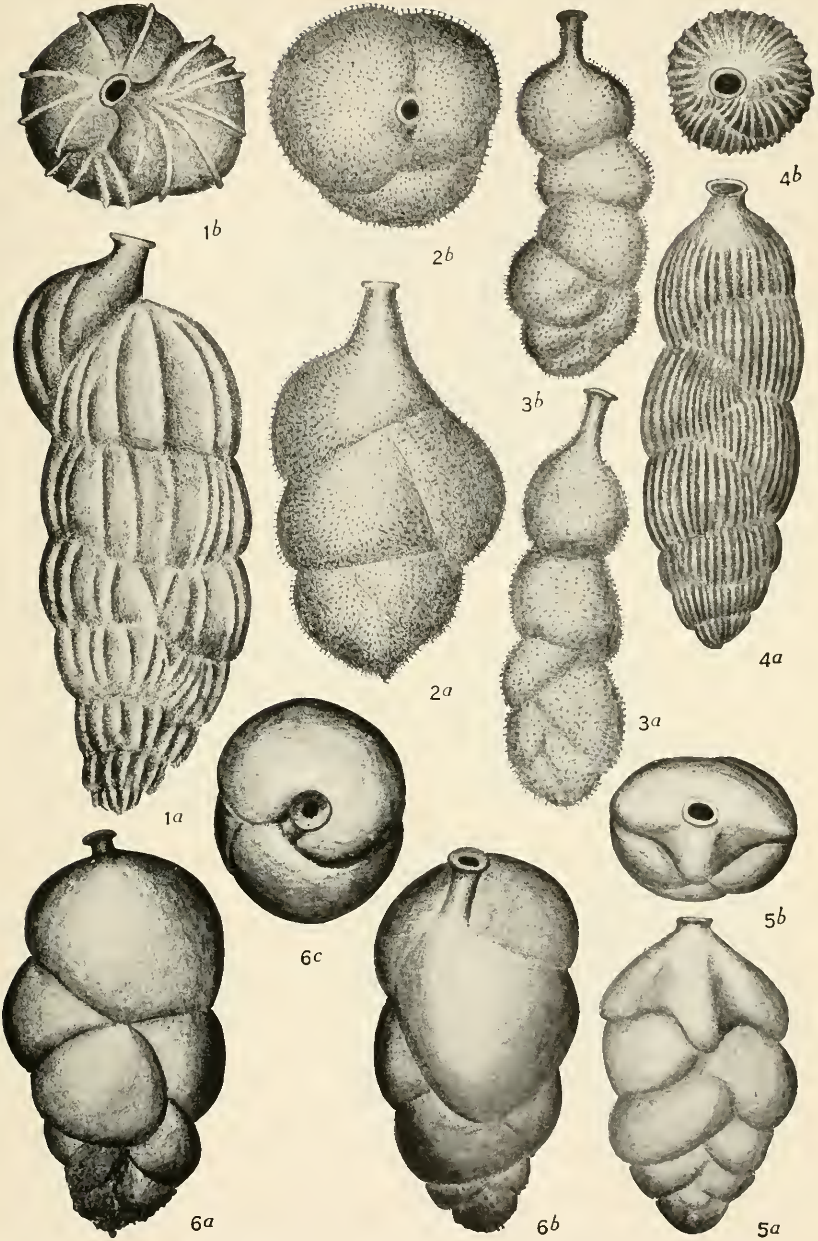
For explanation of plate see page 117.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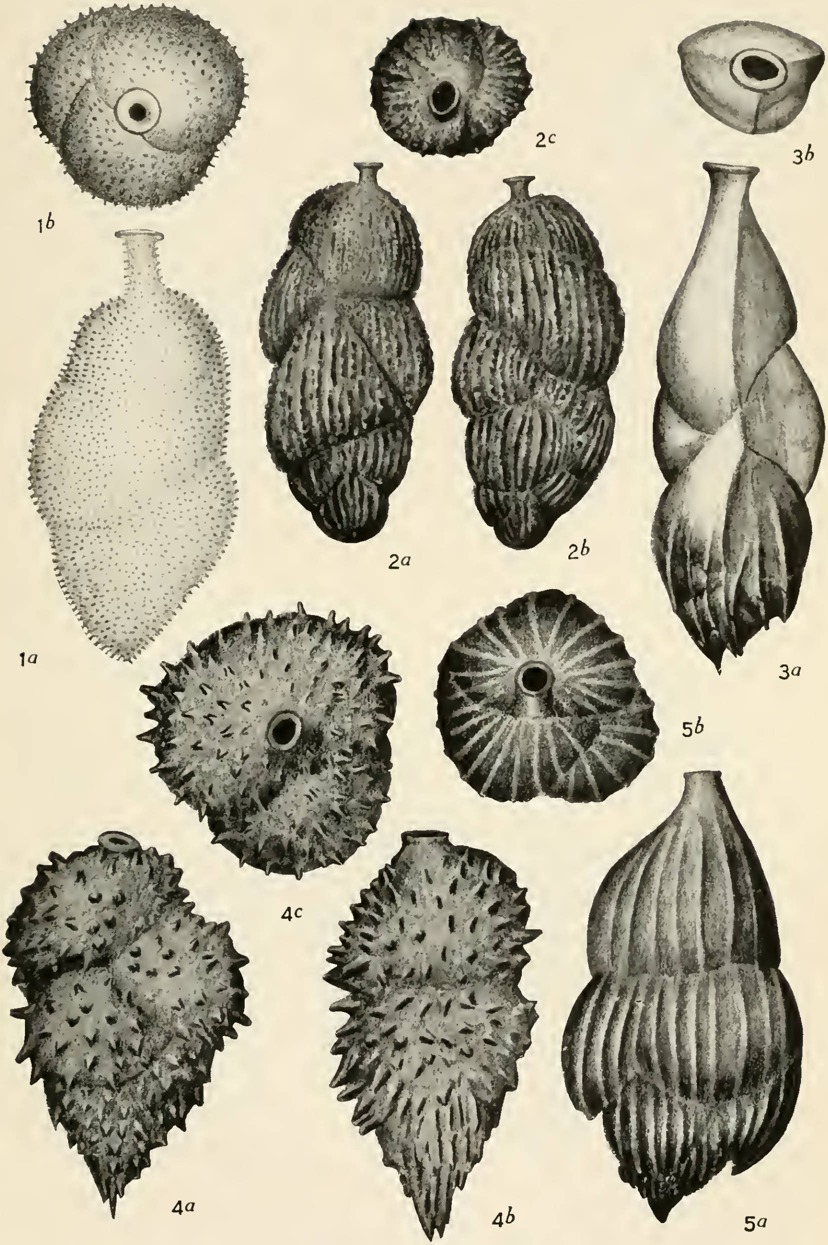
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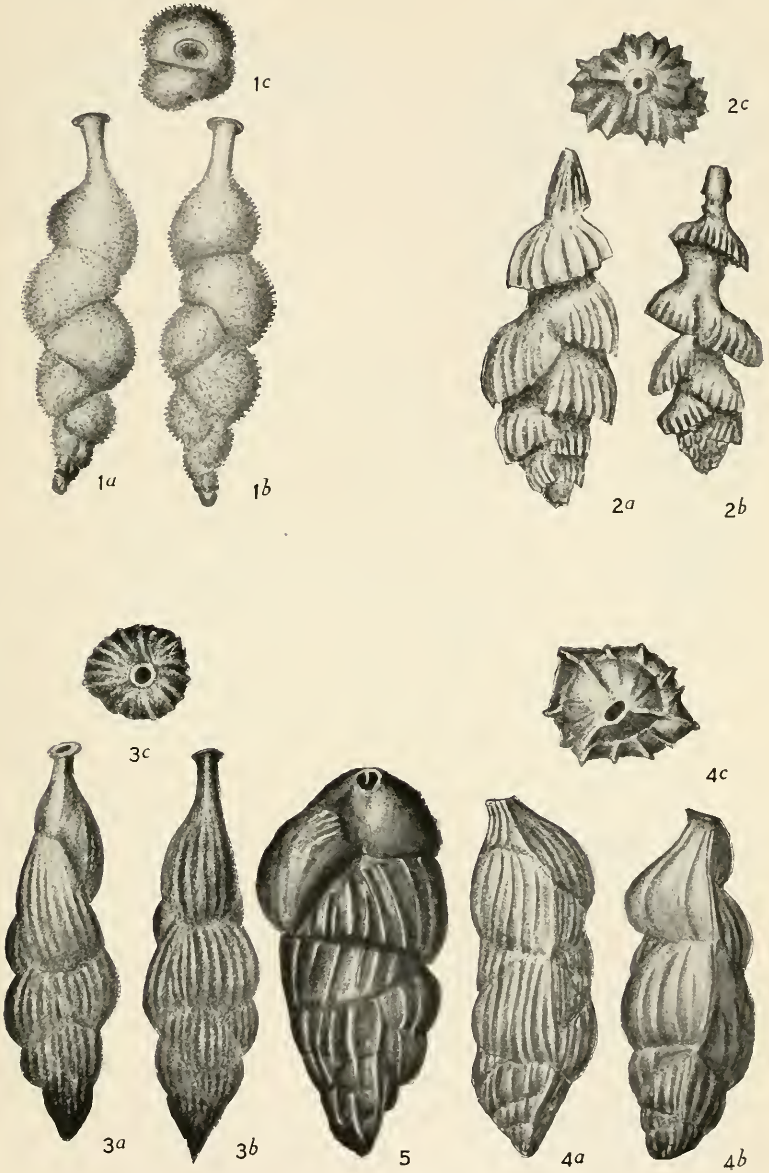
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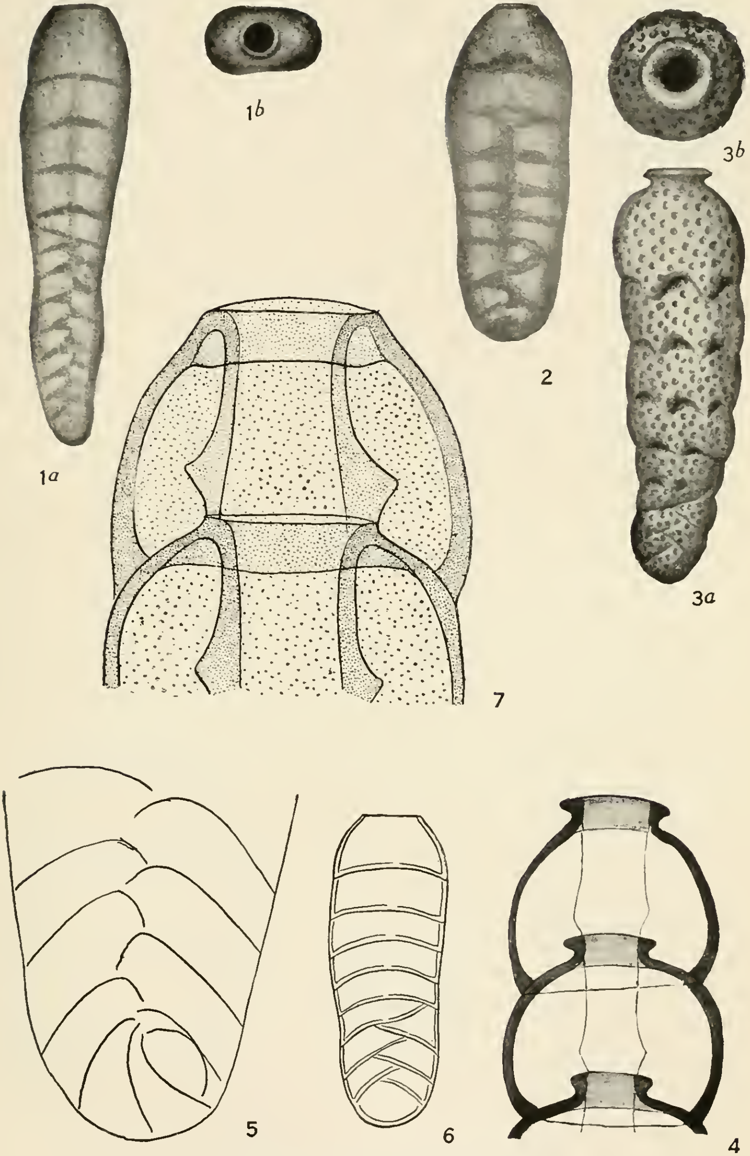
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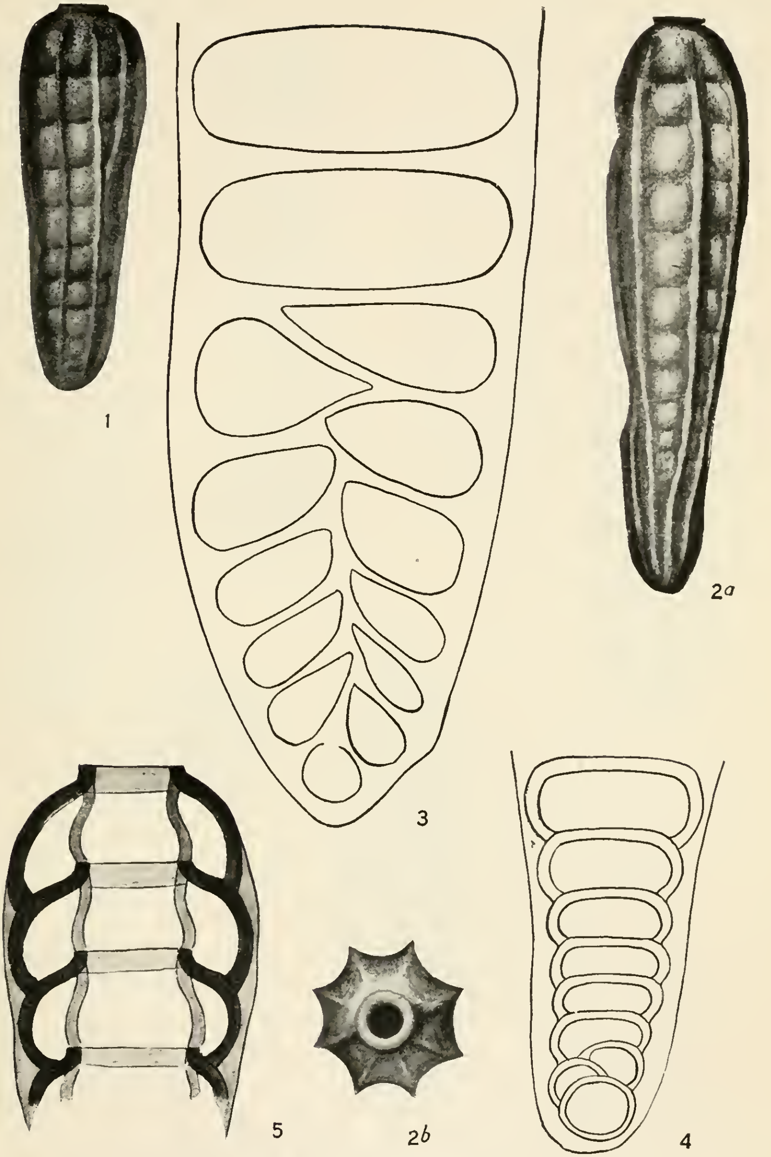
FOR EXPLANATION OF PLATE SEE PAGE 118.



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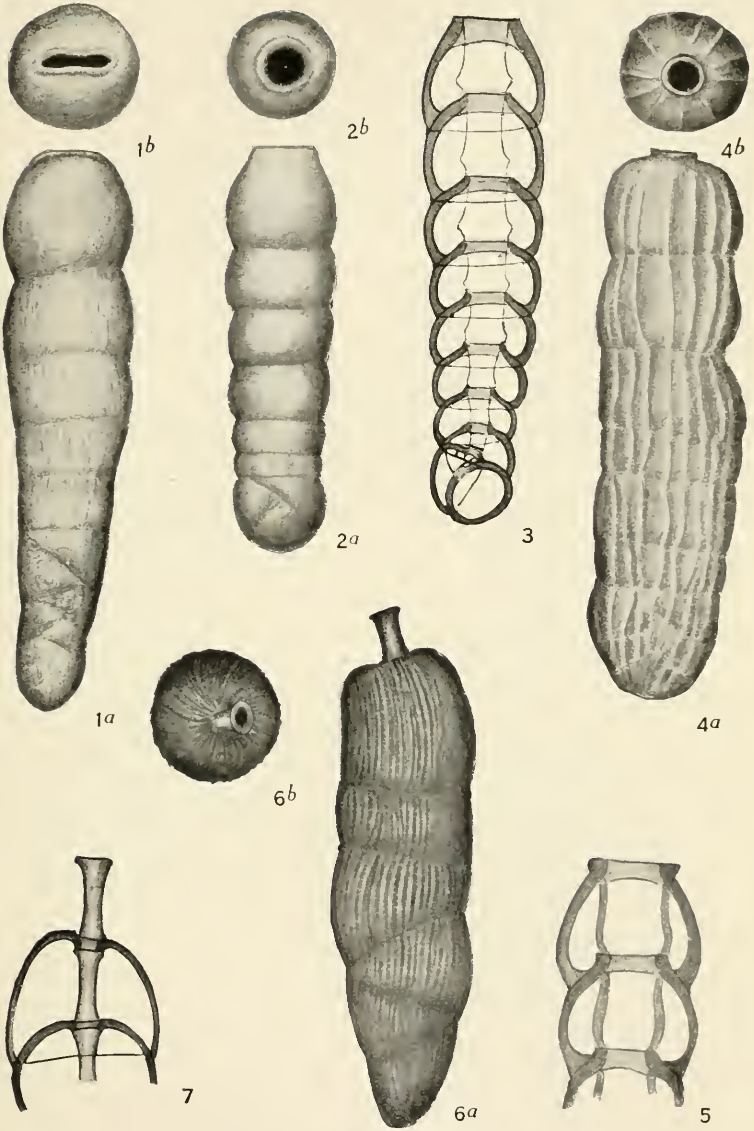
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PART IV. CHILOSTOMELLIDÆ, GLOBIGERINIDÆ NUMMULITIDÆ

BY

JOSEPH AUGUSTINE CUSHMAN
Of the Boston Society of Natural History

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INTRODUCTION.

The present volume is the fourth of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the families Chilostomellidæ, Globigerinidæ and Nummulitidæ. The last family while not appearing in its usual place above the Rotalidæ is included here simply for the better balancing of the present part, the other two included families being comparatively small. The first part, issued in 1910, included the families Astrorhizidæ and Lituolidæ; the second part, issued in 1911, included the family Textulariidæ; and the third part, issued in 1913, included the family Lagenidæ. Part five will be devoted to the Rotalidæ and part six, the last, will be given to the Miliolidæ.

JOSEPH AUGUSTINE CUSHMAN.

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

CHILOSTOMELLIDÆ, GLOBIGERINIDÆ, NUMMULITIDÆ.

By Joseph Augustine Cushman,
Of the Boston Society of Natural History.

INTRODUCTION.

This fourth part of the work on the North Pacific Foraminifera deals with three comparatively small families. In the natural order of sequence the family Nummulitidæ should follow the Rotalidæ, but it is here included so that the next part may be devoted entirely to the Rotalidæ and the final part to the Miliolidæ.

As these families have been long worked on and especially the Globigerinidæ are of world-wide distribution it has been unnecessary to describe new species. Although the North Pacific as a whole is an area of red clay owing to the great depth, nevertheless in many parts it has immense deposits of typical Globigerina ooze, and these with certain restrictions which will be noted are very similar to those of the North Atlantic.

The Nummulitidæ are rather poorly represented in the material, largely due to the fact that most of the North Pacific material which has been at my disposal has come from deep water and for the most part outside the Tropics. The Nummulitidæ, especially the larger forms, are characteristic of shallow tropical regions, especially abundant about coral reefs. Such habitats occur about the Hawaiian Islands and the Philippines, and here they are abundant, especially in the latter archipelago, but unfortunately the material from this region available for the present work is very limited. One interesting feature is the occurrence of these tropical forms up to the southern coast of Japan, where, as has already been several times noted, the southern East Indian fauna seems to reach its northern limits in this region.

Certain of the Globigerinidæ have been illustrated by photographs taken at the United States National Museum from mounted specimens. While these are too small to give minute detail they show in a general way the actual appearance of the specimens better than drawings.

SYSTEMATIC TREATMENT.

A systematic presentation of the three families follows, the arrangement of the data being the same as in preceding parts of this monograph.

Family 6. CHILOSTOMELLIDÆ.

Test calcareous, conspicuously punctate, chambers inflated, ovate, coiled, the chambers in various genera making up a greater or less proportion of the volution; aperture a curved opening between the base of the chamber and its predecessor.

This family in the present oceans is represented by two genera, *Chilostomella,* in which the chamber takes up 180° of the periphery as added, and *Allomorphina,* in which it takes up typically 120°.

Instead of being related closely to the Textulariidæ this family seems more closely related to the Globigerinidæ in many ways.

Genus CHILOSTOMELLA Reuss, 1850.

Chilostomella Reuss (type, *C. ovoidea* Reuss), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 379.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 436.

Description.—Test composed of a series of chambers in a coil, each chamber making a half coil of 180° and embracing so that but a small part of the preceding chamber is visible; wall smooth, finely perforate; aperture at the inner margin of the ventral face of the chamber, curved.

This genus is unlike any others of the perforate type in its having but two visible chambers, in its translucent perforate walls, and in the peculiar arched aperture. It has been described as an alternating series of chambers but seems to be really a coiled test in which each chamber takes up 180° of the volution.

CHILOSTOMELLA OVOIDEA Reuss.

Plate 1, figs. 1–5.

Chilostomella ovoidea Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380, pl. 48, fig. 12.—H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 280, pl. 8, figs. 11, 12; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 436, pl. 55, figs. 12–23.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1889, p. 485, pl. 11, fig. 12.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 305, pl. 9, figs. 1, 2.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 53, pl. 9, figs. 512–516; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 50.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 14.

Description.—Test composed of several chambers, ovoid, but two visible from the exterior, increasing in size rapidly as added, but a small portion of the second chamber visible; wall smooth, translucent, very thin, finely punctate; aperture a curved, somewhat arched opening between the base of the chamber and the preceding one, often with a slightly thickened somewhat flaring lip.

Length up to 1 mm.

Distribution.—Brady records this species from six *Challenger* stations in the North Pacific at depths ranging from 95 to 3,125 fathoms. Goës records it from eight *Albatross* stations in the western Pacific at depths ranging from 770 to 1,832 fathoms. I have had it from several *Albatross* and *Nero* stations off the Galapagos Islands, off the Hawaiian Islands, off Guam and Japan, depths ranging from 323 to 2,256 fathoms. It has occurred usually as single specimens.

There is some considerable variation in the amount of overlapping of the chambers and a coincident variation in the form of the aperture and its lip.

Genus ALLOMORPHINA Reuss, 1850.

Allomorphina Reuss (type, *A. trigona* Reuss), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 437.

Description.—Test made up of a few ovate chambers, in a coil, each chamber making up 120° of the volution so that but three chambers are visible from the exterior; wall thin, translucent, punctate; aperture a narrow slit at the base of the chamber.

This genus is very similar to *Chilostomella* in its general characters of the wall, but differs mainly in the arrangement of the chambers in the coil, which in *Allomorphina* each make up 120° of the volution, whereas in *Chilostomella* they take up 180°.

ALLOMORPHINA TRIGONA Reuss.

Plate 1, figs. 6–8.

Allomorphina trigona Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380, pl. 48, figs. 14*a*–*e*.—Schwager, Boll. Com. Geol. Italia, vol. 8, 1877, p. 26, pl. 71.—H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 67, pl. 8, figs. 13, 14; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 438, pl. 55, figs. 24–26.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 305, pl. 9, figs. 3, 4.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 53, pl. 9, figs. 517–519.

Description.—Test composed of several ovate chambers, coiled each chamber making 120° of the volution and embracing so that but three chambers are visible from the exterior, chambers longer than wide, inflated, sutures somewhat depressed; wall smooth, conspicuously punctate, usually thin and translucent; aperture a narrow curved opening at the base of the ventral margin of the chamber between it and the previously formed adjacent chamber.

Length about 0.40–0.60 mm.

Distribution.—Brady reports this species from the Pacific. It has not appeared in the material which I have examined. The figures are from Brady.

Family 7. GLOBIGERINIDÆ.

Test composed of numerous chambers, usually much inflated, arranged in a trochoid or planospiral coil, often umbilicate, calcareous and perforate walls; aperture either large and single or with numerous accessory apertural openings.

This family, while not consisting of a large number of species or genera, is nevertheless one of the most numerous of the present ocean in regard to numbers of individuals and in the deposits of the present ocean bottom. Making up as it does the great proportion of the enormous amount of pelagic foraminifera and composing the great proportion of the mass of the *Globigerina* ooze which makes up the most of the ocean bottom between 500 and 2,000 fathoms, its importance may be realized.

Among the fossils it makes up the mass of the various chalk deposits and has a long geological history. At the present time, however, perhaps its greatest interest is in the modifications of the test for pelagic life.

In order that the greatest amount of surface may be allowed for the bulk of the test, there is a tendency, in the pelagic forms of the family at least, to assume as nearly as possible a spherical form. The chambers individually assume a spherical contour, and even when made of several chambers the whole test in the various genera tends to take on a subspherical outline. This is carried to perfection in *Orbulina*, where the final chamber is a perfect sphere. In the pelagic forms the protoplasm is protruded from the test and forms a vesicular mass about the exterior. This is probably aided somewhat by the long radiating spines which are usually present in fresh pelagic specimens. In order that the protoplasm may have free access to the exterior, the apertures in this family are as a rule large, especially in pelagic species; where they are not large they are often numerous, as in *Candeina*. In *Globigerina* the apertures from several chambers may enter upon a common umbilical cavity, or in the higher development, as in *G. conglobata*, *sacculifera*, etc., there are numerous accessory apertural openings so that there is a large amount of space allowing perfectly free communication with the exterior.

The surface of the wall of the test is very characteristic in many species, consisting of a reticulated pattern with the pores at the base of the depressions.

The distribution, especially of the pelagic species, is world-wide, but seems to reach its greatest development in the warmer waters of the oceans.

Genus GLOBIGERINA d'Orbigny, 1826.

Globigerina D'ORBIGNY (type, *G. bulloides* d'Orbigny) Ann. Sci. Nat., vol. 7, 1826, p. 277.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 589.

Description.—Test composed of subglobular, inflated chambers, variously arranged, in the early stages at least in a coiled form either planospiral or trochoid; wall typically coarsely perforate, reticulate; aperture large, arched, at the base of the inner margin of the chamber, in some species more than one aperture.

This genus, comprising numerous well distinguished species, makes up the large proportion of the pelagic group of the Foraminifera and is the great constituent of *Globigerina* ooze. The range of structure and method of development of the test is remarkable and under the microscope the reticulated surface, combined with the curves of the sutures and the spherical chambers, make the various members of this genus very beautiful and interesting. It is remarkable that several of the largest and now best known and most abundant of the species should not have been known until the *Challenger* expedition, but it is all the more to the credit of that pioneer work in the deep water of the oceans. The form and surface structure of *Globigerina* is so distinctive that its members are easily distinguished from any other genus, unless perhaps it may be *Candeina* or *Hastigerina*, but these have their own distinctive characters, as will be noted.

The larger part of the figures illustrating the various species of *Globigerina* are from photographs taken at the United States National Museum and for the most part having a magnification of ×35 unless otherwise noted. These show well the general characters of the species.

GLOBIGERINA BULLOIDES d'Orbigny.

Plate 2, figs. 7–9; plate 9.

Globigerina bulloides D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 277, No. 1; Modèles, No. 17 and No. 76; Foram. Voy. Amér. Mérid., 1839, p. 37; in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, 1839, pt. 2, Foraminifères, p. 132, pl. 2, figs. 1–3, 28; Foram. Foss. Bass. Tert. Vienne, 1846, p. 163, pl. 9, figs. 4–6.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 291, pl. 11, figs. 11, 12.—WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 56, pl. 5, figs. 116–118.—STACHE, *Novara*-Exped., Geol. Theil, vol. 1, 1864, p. 286, pl. 24, figs. 35*a–d*.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 21, pl. 2, fig. 56; p. 31, pl. 2, fig. 55.—TERQUEM, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 85, pl. 9 (17), figs. 2*a*, *b*.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 90, pl. 6, figs. 195–207.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 172, pl. 3, fig. 3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 593, pl. 77; pl. 79, figs. 3–7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225. pl. 45, fig. 15.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 561, pl. 11, fig. 17.—WOODWARD and THOMAS, Geol. Nat.

Hist. Survey Minnesota, vol. 3, 1893, p. 40, pl. D, figs. 14–17.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 362, pl. 13, figs. 1–3.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 83, pl. 14, figs. 754–760.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 245, pl. 4, figs. 7–9.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 579, pl. 1, fig. 4.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 321, pl. 69, fig. 2.—RHUMBLER, in Brandt, Nordisches Plankton, Heft. 14, 1900, p. 21, figs. 24–26.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 685.—BAGG, Bull. U. S. Geol. Surv., No. 268, 1905, p. 41, pl. 7, fig. 7; Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 3; vol. 54, No. 16, 1910, p. 23.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 77, pl. 23, figs. 2–8.

Description.—Test subglobose, spiral, composed of few chambers, inflated, subspherical, all visible from above, three to four visible from below, umbilicate, sutures deep; surface reticulate, with spines when in a perfect state of preservation; aperture from each chamber, large, opening into a central umbilical depression.

Diameter, 0.30–0.80 mm.

Distribution.—Brady speaks of this species in the *Challenger* Report as found "wherever Foraminifera have been collected." Bagg records it at each of the nineteen stations from which he had material, off the Hawaiian Islands. I have records of its occurrence at more than a hundred *Nero* stations between Guam and Yokohama and then stopped recording as it was found at nearly every station where any *Globigerina* types occurred. Some of the records are as shallow as 55 fathoms, near the Hawaiian Islands and from that it occurred at stations down to 2,543 fathoms.

The variety *triloba* Reuss occurs with the typical nearly everywhere but seems much less common.

GLOBIGERINA DUBIA Egger.

Plate 4, figs. 1–3.

Globigerina dubia EGGER, Neues Jahrb. für Min., 1857, p. 281, pl. 9, figs. 7–9.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 71; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 595, pl. 79, figs. 17*a–c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 366, pl. 13, figs. 36–38, 77.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 4.—RHUMBLER, in Brandt, Nordisches Plankton, Heft. 14, 1900, p. 19, fig. 20.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 686.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 154; Bull. U. S. Geol. Surv., No. 513, 1912, p. 79, pl. 22, figs. 4*a–d*.

Description.—Test composed of numerous inflated chambers arranged in a nautiloid spiral, chambers all visible from above, umbilicate below, with only the chambers of the last volution visible, usually 5 to 6 in number; wall reticulate; apertures of the chambers opening into the umbilical cavity.

Diameter, 0.50–0.80 mm.

Distribution.—Like the foregoing species this is found almost always when *Globigerina* types are found. It is recorded by Brady in the *Challenger* Report from the North Pacific; by Bagg from eight *Albatross* stations off the Hawaiian Islands. I have had material from a great numbėr of stations wherever *Globigerina* ooze material has occurred.

This species, while related to *G. bulloides,* has a much more definite form and the coiling is very even; the outline from above or below is nearly circular.

GLOBIGERINA CRETACEA d'Orbigny.

Globigerina cretacea d'ORBIGNY, Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 34, pl. 3, figs. 12–14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 596, pl. 82, figs. 10*a–c* (?).—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.

Description.—Test similar in general characters to *G. dubia* but more compressed, number of chambers larger in each coil, smaller in size.

Diameter about 0.5 mm.

Distribution.—In the North Pacific Bagg records this species from three *Albatross* stations off the Hawaiian Islands, in 572–1,343 fathoms.

While the fossil forms described by d'Orbigny seem to be distinctive, in the recent material there seems to me to be little to separate these two forms.

GLOBIGERINA DIGITATA H. B. Brady.

Plate 14, figs. 1–3.

Globigerina digitata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 599, pl. 80, figs. 6–10; pl. 82, figs. 6, 7.—TERRIGI, Mem. Accad. Nuovi Lincei, ser. 4, vol. 6, 1889, p. 113, pl. 6, fig. 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 369, pl. 13, figs. 25, 60, 61.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 323, pl. 70, fig. 2.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.

Description.—Test spiral, regular, consisting of two or three volutions, early chambers inflated, subspherical, later chambers much elongated, pointed or otherwise modified at the tip, spreading radially; wall reticulate; aperture opening into the central umbilical opening, or in the elongate chambers making up the larger part of the base of the chamber, the area of attachment being very much reduced.

Diameter in adults up to 2 mm.

Distribution.—Bagg records this species from seven stations of the *Albatross* in the vicinity of the Hawaiian Islands, depths ranging from 384 to 1,259 fathoms. I have had material from about the Hawaiian Islands, *Nero* station 2037 in 55 fathoms, the shallowest, and from about Guam at several *Nero* stations, 891 to 1,143 fathoms. It occurs usually in but small numbers.

This is a pelagic species and in the adult with the very large apertures it is easily possible for the sarcode to extend out to form the usual vesicles. The tips of the long chambers are pointed, flattened, fimbriate or even sometimes show a tendency toward branching.

GLOBIGERINA DUTERTREI d'Orbigny.

Globigerina dutertrei d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 95, pl. 4, figs. 19–21.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 601, pl. 81, figs. 1*a–c*.

Description.—"Test Rotaliform, suborbicular, both faces convex, margin thick and rounded; composed of about three convolutions, the last of which consists of five segments; segments gradually increasing in size from the commencement, somewhat inflated, especially the later ones; aperture a single arched orifice at the inferior umbilical margin of the final segment.

"Diameter, $\frac{1}{50}$th inch (0.5 mm.) or less."

Distribution.—The only record for this species in the North Pacific is that of Picaglia, who records it from a single station of the *Vettor Pisani*, long. 109° 58′ W.; lat. 0° 47′ N., depth 4,670 m.

I have found no material which seems referable to this rather doubtful species. The description is from Brady.

GLOBIGERINA INFLATA d'Orbigny.

Plate 4, figs. 4–8.

Globigerina inflata d'Orbigny, in Barker, Webb and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, 1839, Foraminifères, p. 134, pl. 2, figs. 7–9.—H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 601, pl. 79, figs. 8–10.—Balkwill and Millett, Journ. Micr., vol. 3, 1884, p. 84, pl. 4, fig. 11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 369, pl. 13, figs. 45–47.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 85, pl. 14, figs. 763–765.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 3.—Fornasini, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 577, pl. 1, fig. 3.—Rhumbler, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 19, fig. 19.—Millett, Journ. Roy. Micr. Soc., 1903, p. 687.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 23.

Globigerina bulloides, var. *inflata* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 367, pl. 16, figs. 16, 17.

Description.—Test composed of numerous inflated chambers, usually arranged in a spiral test of about three volutions, the last one composed of four chambers, upper side of test flattened, lower end of chambers prolonged so that in side view the test is about as high as broad; surface reticulate, but usually less conspicuously so than most of the other species of the genus; aperture a long arched opening at the base of the inner face of the chamber.

Diameter 0.40–0.80 mm.

Distribution.—Brady notes the occurrence of this species in the North Pacific at five *Challenger* stations, depths ranging from 345 to 3,125 fathoms. Bagg does not record it. I have found the species at a very large number of *Nero* stations, depths ranging from 264 to 2,543 fathoms, well scattered over the area. It has also occurred at various *Albatross* and *Tuscarora* stations.

GLOBIGERINA RUBRA d'Orbigny.

Plate 3, figs. 6–9.

Globigerina rubra D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 94, pl. 4, figs. 12–14.—BAILEY, Smiths. Contr., vol. 2, 1851, p. 11, pl., figs. 23, 24.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 602, pl. 79, figs. 11–16.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225, pl. 45, fig. 12.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 360, pl. 13, figs. 42–44.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 85, pl. 14, fig. 766.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 262, pl. 5, fig. 4.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 5.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 580, pl. 2, fig. 11.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 687.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 154.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 4; vol. 54, No. 16, 1910, p. 23.

Description.—Test composed of several inflated chambers arranged in an elongate trochoid spire of about three volutions each with three chambers; walls reticulate, with spines in pelagic specimens; aperture an arched opening at the umbilical border of the chamber and in the later chambers this is supplemented by two or more nearly circular openings on the upper border of the chamber near its connection with the preceding chambers; color of the early chambers, sometimes of all the chambers, pink.

Length about 0.75 mm.; diameter about 0.50 mm.

Distribution.—This species is not nearly so abundant in the North Pacific as are most of the others of the genus. Brady records it from the Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. Bagg records it from thirteen *Albatross* stations also in the vicinity of the Hawaiian Islands, depths ranging from 275 to 1,544 fathoms. I have records of its occurrence at 26 *Nero* stations well scattered from the Hawaiian Islands to Guam and Yokohama but it has usually occurred in small numbers.

This is a beautiful species when its delicate coloring is well preserved, but in the material I have seen there is but a small amount of this species compared to what is found in material from the West Indian region.

The high spire of this species with its peculiar accessory apertural openings will at once distinguish this species, even though the color may be lacking, as is often the case.

GLOBIGERINA CONGLOBATA H. B. Brady.

Plate 3, figs. 3–5; plate 10, figs. 1, 6.

Globigerina conglobata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 603, pl. 80, figs. 1–5; pl. 82, fig. 5.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225, pl. 45, fig. 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 368, pl. 13, figs. 55, 56.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 86, pl. 14, figs.768, 769; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 66.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 6.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 582, pl. 2, figs. 12–15; pl. 3, figs. 1–5.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 688.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.

Description.—Test subglobular, early chambers arranged in a compact spiral; in the adult the last three chambers form the last volution taking up nearly the whole surface of the test; wall strongly reticulate; in pelagic specimens with delicate spines; aperture at the inner margin of the chamber with several rounded accessory apertures along the sutures between the chamber and the previous ones to which it is adjacent.

Diameter up to 1 mm.

Distribution.—Brady records this as found in the North Pacific in the *Challenger* surface tows as well as at two bottom stations, 214 in 500 fathoms and 224 in 1,850 fathoms. Bagg records it from 15 out of 19 *Albatross* stations near the Hawaiian Islands in 275 to 1,544 fathoms.

I have found the species to be abundant in material dredged by the *Albatross* between San Francisco and the Hawaiian Islands and at a great number of *Nero* stations wherever *Globigerina* ooze conditions were encountered. It also occurs frequently in the *Alert* and *Tuscarora* material.

This is a very characteristic species and it is singular that it was not found previous to the *Challenger* expedition. The globose form, with the three chambers making up practically all the visible test and the peculiar accessory apertural openings, will distinguish this species from any others.

Evidently this is one of the highest of the species of the genus. It is often almost globose, the accessory apertural openings numerous and large, especially in adult specimens. It is apparently a rare species outside of the recent oceans, its occurrence as a fossil being practically unknown.

In the north Pacific material this is often the characteristic species of the genus.

GLOBIGERINA SACCULIFERA H. B. Brady.

Plate 2, figs. 4–6; plate 5; plate 10, fig. 4.

Globigerina helicina CARPENTER, (not *G. helicina* d'Orbigny), Intr. Foram., 1862, pl. 12, fig. 11.

Globigerina sacculifera H. B. BRADY, Geol. Mag., Dec. 2, vol. 4, 1877, p. 535; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 73; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 604, pl. 80, figs. 11–17; pl. 82, fig. 4.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 369, pl. 13, figs. 50, 51.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 66.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 263, pl. 5, fig. 5.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 70, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 688.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 154.

Description.—Test composed of numerous chambers, in its early stages very similar to *G. bulloides* but later developing a more oblong form, the chambers extended, somewhat compressed and with accessory apertural openings, the final chamber often flattened and irregularly formed toward the outer end; wall strongly reticulated in all but the final chamber which is much smoother than the others; aperture large, arched with other accessory openings in the chambers of adult specimens.

Diameter up to and sometimes slightly exceeding 1 mm.

Distribution.—Brady records this species from three North Pacific *Challenger* stations, ranging in depth from 345 to 1,850 fathoms. Bagg records it from all but one of the nineteen *Albatross* stations in the vicinity of the Hawaiian Islands from which he examined material. I have found this species present and often in considerable numbers in material from a very large number of North Pacific stations in the *Albatross, Nero, Alert,* and *Tuscarora* material. These stations range in depth from 268 to 2,552 fathoms.

This species is easily distinguished, especially in its adult form. In some specimens where the accessory apertures are large it is possible to look through the opening between the last chambers and those of the previous whorl. The figured specimen shows the general character of the last chamber, its smoother surface and the accessory apertural openings.

As noted in regard to the preceding species this species seems to be practically unknown as a fossil form. By its large openings it is one of the highest developed species of the genus.

The last-formed chamber in adults is often very variable in shape, especially the outer border, which is often deeply lobed and irregularly extended.

GLOBIGERINA HELICINA d'Orbigny.

Plate 3, figs. 1, 2.

Globigerina helicina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 277, No. 5.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 175, pl. 11, fig. 113.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 287; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 605, pl. 81, figs. 4, 5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 370, pl. 13, fig. 52.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 264, pl. 5, fig. 6.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 583, pl. 3, figs. 11, 12.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 688, pl. 7, fig. 1.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 154.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 4, pl. 1, fig. 9.

Description.—Test oblong or ovate, composed of several chambers more or less irregularly arranged, inflated, the later chambers being added on the periphery of the test without regard to the spiral arrangement of the earlier ones; wall reticulate; aperture on the basal side of the inner margin of the chamber but also are added one or more accessory apertural openings on the upper side of the test, especially in the added last chambers.

Diameter up to 1 mm.

Distribution.—Bagg records this species as rare at *Albatross* station H 4696 in 367 fathoms off the Hawaiian Islands. I have it also from the same region, *Albatross* station H 2923 in 392 fathoms where it occurred with several specimens here figured.

It may be a question as noted by Brady whether this may not be an abnormal development of some other species, as it seems to occur but rarely and always shows an irregular form.

GLOBIGERINA ÆQUILATERALIS H. B. Brady.

Plate 2, figs. 1–3; plate 10, fig. 5.

Cassidulina globulosa (part) EGGER, Neues Jahrb. für Min., 1857, p. 296, pl. 11, fig. 4.

Globigerina æquilateralis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 71; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 605, pl. 80, figs. 18–21.—WRIGHT, Proc. Belfast Nat. Field Club, 1884–85, App. 9, 1886, p. 332, pl. 27, fig. 9.—CHAPMAN, Quart. Journ. Geol. Soc., vol. 48, 1892, p. 517, pl. 15, fig. 14.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 364, pl. 13, figs. 5–8.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 86, pl. 14, fig. 767.—CHAPMAN, Journ. Roy. Micr. Soc., 1896, p. 589, pl. 13, fig. 7.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 66.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 265, pl. 5, fig. 8.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 580, pl. 4, figs. 3, 4.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 323, pl. 70, fig. 3.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 20, figs. 21–23.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 689.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 152.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 4, pl. 1, fig. 10.

Description.—Test composed of numerous inflated chambers arranged in a bilaterally symmetrical, planospiral coil of one and a half to two volutions; chambers increasing rapidly in size as added, usually 5 to 6 visible in side view, sutures much depressed giving a lobulated contour; wall reticulate, often with broken spines; aperture large, an arched opening at the base of the chamber.

Diameter up to 1 mm.

Distribution.—Brady records this species in the North Pacific from the following *Challenger* stations, Honolulu coral reefs, 40 fathoms; station 206 in 2,100 fathoms, 214 in 500 fathoms, and 224 in 1,850 fathoms. Bagg records it from 18 *Albatross* stations off the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms. I have had material from numerous *Albatross* stations between San Francisco and the Hawaiian Islands, depths ranging from 323 to 2,615 fathoms. It has occurred at a great number of stations of the *Nero* wherever those soundings were below 2,000 fathoms across the Pacific and especially between Yokohama and Guam where I have record of its occurrence at 40 stations. It has also occurred in the material from the soundings of the *Alert* and *Tuscarora* and off Japan in the *Albatross* work as well as off the Galapagos Islands. Altogether it seems to be well distributed in the North Pacific and to occur abundantly at many stations.

The planospiral arrangement of the chambers in this species will distinguish it from the others of the genus. There is some considerable variation in the closeness of the coiling in various specimens. In old-age specimens there is a tendency to reduce the size of the last-formed chamber and to make it less high and of smaller diameter than the preceding one.

Genus ORBULINA d'Orbigny, 1839.

Orbulina D'ORBIGNY (type, *O. universa* d'Orbigny), in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 606.

Description.—Test composed of several *Globigerina*-like chambers, rapidly increasing in size as added, finally entirely surrounded by the adult chamber which is spherical, with numerous small pores and one large circular orifice, or occasionally more than one; wall reticulated, in living condition with long, fine spines.

There has been much discussion in the past in regard to the position of *Orbulina* and its relation to *Globigerina*. It seems best now that something is known of the development to recognize *Orbulina* as a genus derived from *Globigerina* ancestry, the adult final chamber inclosing the earlier ones being a good generic character. It is comparable to certain of the Miliolidæ where a similar inclosing of the earlier developed chambers takes place.

In *Orbulina* there seems to be a process of resorption by which the interior chambers disappear in the adult specimens, the smaller, thinner specimens having such included chambers, whereas they almost never are found in large well-developed specimens.

ORBULINA UNIVERSA d'Orbigny.

Plate 6; plate 7; plate 11, fig. 3.

"Polymorpha sphærulæ vitreæ," SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, p. 116, pl. 119, figs. *I–N*.

Orbulina universa D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 3, pl. 1, fig. 1; in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, Foraminifères, 1839, p. 122, pl. 1, fig. 1; Foram. Foss. Bass. Tert. Vienne, 1846, p. 22, pl. 1, fig. 1.—BAILEY, Smiths. Contr., vol. 2, 1851, p. 9, pl., fig. 1.—WILLIAMSON, Rec. For. Great Britain, 1858, p. 2, pl. 1, fig. 4.—CARPENTER, PARKER, and JONES, Intr. Foram., 1862, p. 176, pl. 12, fig. 8.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 364, pl. 16, figs. 13, 14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 608, pl. 78; pl. 81, figs. 8–26; pl. 82, figs. 1–3.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 174, pl. 4, figs. 25–31.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 9.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225, pl. 45, figs. 7, 8, 14.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 374, pl. 14, figs. 7–9, 11, 12, 39, 40.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 3, 1893, p. 430, pl. 2, fig. 12.—LISTER, Philos. Trans., vol. 186, 1895, p. 408, figs. *a–e*.—RHUMBLER, Abh. deuts. Zool. Ges., 1897, p. 174, fig. 21.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 266, pl. 5, figs. 11–16, 19–22.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 1.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 27, figs. 27–30.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 690.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 5; vol. 54, No. 16, 1910, p. 24.—BAGG, Bull. 513, U. S. Geol. Surv., 1912, p. 79, pl. 23, fig. 1.

Description.—Test composed of a series of *Globigerina*-like chambers followed by and inclosed by a globular chamber, surface reticulate with a pit at the bottom of each reticulation and one larger, circular aperture; surface with long spines in the living condition.

Diameter up to 1 mm.

Distribution.—Little need be said of the distribution of this species which seems to be found nearly always in any sample of typical *Globigerina* ooze. Brady simply speaks of it as cosmopolitan. Bagg records it from all 19 of the *Albatross* stations from which he examined material from off the Hawaiian Islands. Picaglia notes it from two stations of the *Vettor Pisani* in the North Pacific. Flint notes it from various *Nero* stations.[1]

I have found it common in material from the *Albatross, Nero, Tuscarora,* and *Alert* soundings wherever such soundings came into the regions of *Globigerina* ooze.

There is a tendency in specimens to show many layers in the wall of the final chamber, and it may be that the test increases by addition of material from without and resorption from within. At least various sizes are found in the material, suggesting that there must be some increase in size.

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[1] Bull. U. S. Nat. Mus., No. 55, 1905, pp. 16, etc.

This is one of the commonest of the pelagic species and has the sarcode extended in a living condition into the bubblelike form already referred to here. Various double forms and some with a second chamber showing are occasionally found, and these seem to simply show specimens in which the last formed chamber has not entirely inclosed the preceding ones, similar to *Biloculina sphæra*. One such specimen is figured on plate 7 as fig. 2.

Genus HASTIGERINA Wyville Thomson, 1876.

Plate 8.

Nonionina (part) D'ORBIGNY, Foram. Amér. Mérid., 1839, p. 27.

Lituola (part) JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 302, table No. 181.

Globigerina (part) PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 366.

Hastigerina WYVILLE THOMSON (type, *Hastigerina pelagica* (d'Orbigny)), Proc. Roy. Soc., vol. 24, 1876, p. 534.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 612.

Description.—Test composed of numerous chambers arranged in planospiral manner, inflated; surface with numerous spines, aperture large, broad oval at the inner margin of the chamber. This genus represented by the following species is essentially pelagic.

HASTIGERINA PELAGICA (d'Orbigny).

Plate 8.

Nonionina pelagica D'ORBIGNY, Foram. Amér. Mérid., 1839, p. 27, pl. 3, figs. 13, 14.

Lituola pelagica JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 302, table, No. 181.

Globigerina pelagica PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 366.

Hastigerina pelagica H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 77; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 613, pl. 83, figs. 1–8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 372, pl. 13, figs. 53, 54.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 324, pl. 70, fig. 4.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 273, pl. 5, fig. 9.—RHUMBLER, in Brandt, Nordisches Plankton, 1900, p. 29, fig. 31.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 691.

Hastigerina murrayi WYVILLE THOMSON, Proc. Roy. Soc., vol. 24, 1876, p. 534, pls. 22, 23.

Description.—Test composed of numerous inflated, subglobular chambers in a spiral form, umbilicate, chambers increasing in size progressively as added, sutures much depressed; wall very thin and transparent, clothed with long slender spines which are serrate, especially toward the base; aperture a large, arched, oval opening at the inner border of the chamber.

Diameter of test without spines up to 1.3 mm.

Distribution.—Brady records this species from 12 *Challenger* stations in the North Pacific. Flint[1] records the species or at least the genus from *Nero* station 11 in 1,983 fathoms between the Hawaiian Islands and Midway Island and 166–174, 1,593–2,111 fathoms between Midway Island and Guam. Bagg does not record it from the region of the Hawaiian Islands; and in all the material I have examined I have failed to find specimens, whether from lack of care in searching the material or too rough handling in washing the material, or what, I do not know.

The species may be distinguished from *Globigerina æquilateralis* which it somewhat resembles in contour by the thinner wall and the peculiar spinose character of the surface.

Hastigerina pelagica is truly pelagic, and in the specimens obtained in a living condition by the *Challenger* the sarcode was expanded in the bubblelike form seen in different members of the pelagic group of Foraminifera.

Genus CANDEINA d'Orbigny, 1839.

Candeina d'Orbigny (type, *Candeina nitida* d'Orbigny), in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 107.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 622.

Description.—Test usually in the form of an elevated spire, but may be more or less compressed, chambers several, increasing in size as added, globular or subglobular; wall usually clear, finely perforate, translucent; apertures numerous, elliptical in form along the sutural lines between the chambers.

This genus is unique in the family in the manner of its development of numerous apertural openings along the border of the last formed chamber where it comes in contact with the preceding chambers. It is represented in the North Pacific material by the following species:

CANDEINA NITIDA d'Orbigny.

Plate 11, fig. 1.

Candeina nitida d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 108, pl. 2, figs. 27, 28; Foram. Foss. Bass. Tert. Vienne, 1846, p. 193, pl. 21, fig. 28.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 89, pl. 6, figs. 187–189.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 622, pl. 82, figs.13–20 .—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 373, pl. 13, fig. 57.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 3.—Rhumbler, in Brandt, Nordisches Plankton, vol. 14, 1900, p. 31, fig. 33.—Millett, Journ. Roy. Micr. Soc., 1903, p. 692, pl. 7, fig. 2*a–c*.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 156.

Description.—Test composed of numerous chambers, progressively increasing in size as added, globular or subglobular, arranged in a spire or variously compressed; wall smooth, sutures depressed, punctate; aperture consisting of a series of rounded or elliptical pores at the junction of the last formed chamber with the next preceding chambers.

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[1] Bull. U. S. Nat. Mus., No. 55, 1905, pp. 15, 17.

Diameter of test averaging about 0.75 mm.

Distribution.—Brady records this species from a single North Pacific station in the *Challenger* Report, the depth given being 214–500 fathoms. Bagg records it off the Hawaiian Islands at seventeen *Albatross* stations, the depths ranging from 104–1,544 fathoms. I have had numerous specimens of this species from a large number of stations about the Hawaiian Islands, off Guam, between Guam and Yokohama, and between Guam and Midway Island. It has never occurred in any great numbers. The depths range from 392–2,615 fathoms with the average at about a thousand fathoms.

This species is easily distinguished by its *Globigerina*-like form and its very characteristic apertural openings. It was found by Millett in material from the Malay Archipelago and by Brady in the South Pacific and the regions of the West Indies and various parts of the Atlantic. D'Orbigny's original specimens came from the shore sands of the West Indies, Cuba, and Jamaica.

This species is one of the small number that occur as pelagic forms. The *Challenger* obtained specimens from tow nets in the North Pacific and also in the South Atlantic.

Genus SPHÆROIDINA d'Orbigny, 1826.

Sphæroidina D'ORBIGNY (type, *S. bulloides* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 267.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 619.

Description.—Test composed of a small number of chambers arranged in a short spire, the chambers inflated and increasing rapidly in size and embracing, few only visible from the exterior; wall perforate; aperture an arched opening at or near the inner margin of the chamber, often with a calcareous tooth-like process partially closing the opening.

One of the species, *S. dehiscens,* occurs in the pelagic condition and is especially modified in various ways as are a number of pelagic species.

This genus is found in some numbers in the later Tertiary, but earlier than this does not seem to be at all common.

Various synonyms appear, such as *Sexloculina* Czjzek, and *Grammobotrys,* and *Bolbodium* of Ehrenberg.

SPHÆROIDINA BULLOIDES d'Orbigny.

Plate 10, fig. 7; plate 12, fig. 1.

Sphæroidina bulloides D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 1; Modèles, No. 65.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 58.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 89, pl. 60, figs. 190–193.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 620, pl. 84, figs. 1–7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 45, figs. 9–11.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 562, pl. 11, figs. 20, 21.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 3, 1893, p. 430, pl. 2, fig. 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 375, pl. 13, figs. 48, 49.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 87, pl. 14, fig. 770; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 67.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 692.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 5, pl. 1, fig. 11.

Description.—Test nearly spherical, composed of a few much inflated chambers, arranged in a spire of but about two revolutions, only those of the last formed revolution being visible from the exterior in most specimens; wall smooth and polished, thick, minutely perforate; aperture an arched, semicircular opening, usually nearly closed by a broad flat semicircular tooth.

Diameter on an average about 1 mm.

Distribution.—Brady records this species from four *Challenger* stations in the North Pacific in from 1,850 to 2,300 fathoms. Goës records it from the western Pacific, *Albatross* D 3407 in 885 fathoms and D 3376 in 1,132 fathoms. Bagg records it from four *Albatross* stations off the Hawaiian Islands, with depths ranging from 572 to 1,398 fathoms.

In the North Pacific material I have examined the species has occurred at many stations, in the region about the Hawaiian Islands and through the various *Nero* soundings as well as off Japan. The depths of the stations have as a rule been more than 1,000 fathoms, the shallowest being 859 and the deepest 2,067 fathoms.

Occasionally specimens are met with which in the final revolution have failed to entirely cover the earlier chambers and the beginning of the spiral development is visible. At first glance this species appears like an imperforate foraminifer the perforations being very fine and indistinct and the wall white and highly polished. In almost all its characters it is in great contrast with the species following.

SPHÆROIDINA DEHISCENS Parker and Jones.

Plate 10, fig. 2; plate 13, fig. 1.

Sphæroidina dehiscens PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 369, pl. 19, fig. 5, *a*, *b*.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 295; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 621, pl. 84, figs. 8–11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 376. pl. 13, figs. 58, 59.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 67.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 2.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.

Globigerina seminulina SCHWAGER, *Novara* Exped., Geol. Theil, vol. 2, 1866, p. 256, pl. 7, fig. 112.

Description.—Test subglobular, composed of a few chambers arranged as in *S. bulloides* but distinguished even in early stages by the large perforations and translucent test; chambers in later development separated by deep fissure-like sutures, often in adult specimens nearly closed by the fimbriated edges of the chamber; wall thick, conspicuously perforate, somewhat reticulate, rough; aperture an arched opening into the chamber from the deep fissure near its base.

Diameter up to 1.5 mm.

Distribution.—Brady records this species from four *Challenger* stations in the North Pacific, depths ranging from 500 to 2,100 fathoms. Picaglia records it from two North Pacific stations of the *Vettor Pisani*. Goës records it from two *Albatross* stations in the western Pacific, D 3371 in 770 fathoms and D 3400 in 1,322 fathoms. Bagg records it from a number of *Albatross* stations near the Hawaiian Islands at depths ranging from 305 to 1,544 fathoms. I have found specimens from a great number of stations in all parts of the North Pacific where *Globigerina* ooze material has been available. In depth these range from 323 to 2,175 fathoms. Often the specimens have been abundant and excellent for showing the developmental stages.

In the young of *S. dehiscens* the test is comparatively smooth but is conspicuously perforate with comparatively large pores. At this time there is almost no trace of the deep sutures and except for the pores and the translucent test the resemblance to a specimen of *S. bulloides* is close. As chambers are added usually a triangular area is left, at first very small and inconspicuous, later becoming more marked, similar to the specimen figured by Schwager noted above. By degrees as chambers are added the sutures become wider and finally in adult specimens they are at the bottom of deep fissures which are wide open, but which in old-age specimens are partially closed near the exterior by the growing in of the side walls near the surface. In such specimens the walls at the edge of these fissures are often considerably raised and fimbriate and the remainder of the wall becomes rough and somewhat reticulate. In the old-age specimens the wall is very thick and the pores are conspicuous in section.

The large pores are similar to what is seen in many other pelagic species. Although usually found as a bottom form this species occurs sparingly as a pelagic form in tow-net gatherings.

Genus PULLENIA Parker and Jones, 1862.

Nonionina (part) d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 293.

Pullenia Parker and Jones (type, *P. sphæroides* (d'Orbigny)), in Carpenter, Parker, and Jones, Intr. Foram., 1862, p. 184.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 614.

Description.—Test composed of several chambers arranged in a planospiral or oblique nautiloid more or less involute spiral, sutures not greatly inflated, only those of the last volution visible; wall smooth, perforations small and indistinct; aperture a curved opening at the base of the inner face of the chamber.

Certain of the characters of this genus make it seem related to such genera as *Nonionina* or *Polystomella*, especially the former, but no complicated structures have been demonstrated here as occur in *Polystomella*. Of the three species *P. obliquiloculata* is most clearly related in form and apertural characters to the Globigerinidæ.

PULLENIA SPHÆROIDES (d'Orbigny).

Plate 11, fig. 2.

Nonionina sphæroides d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 293, No. 1; Modèles, No. 43.

Pullenia sphæroides Parker and Jones, in Carpenter, Parker and Jones, Intr. Foram., 1862, p. 184, pl. 12, fig. 12; Philos. Trans., vol. 155, 1865, p. 368, pl. 14, figs. 43 *a*, *b*; pl. 17, fig. 53.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 615, pl. 84, figs. 12, 13, text fig. 18, p. 616.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 348, pl. 12, figs. 28*a*, *b*.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 10.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 43, figs. 21, 24.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 372, pl. 19, figs. 30, 31.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 87, pl. 14, figs. 771, 772.—Chapman, Proc. California Acad. Sci., ser. 3 (Geol.), vol. 1, 1900, p. 252, pl. 30, fig. 6.—Millett, Journ. Roy. Micr. Soc., 1903, p. 691.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.

Nonionina bulloides d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 293, No. 2; Foram. Foss. Bass. Tert. Vienne, 1846, p. 107, pl. 5, figs. 8–10.

Pullenia bulloides Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1866, p. 150.

Description.—Test subglobular, somewhat laterally compressed, composed of numerous chambers making three to four volutions, each consisting of four chambers, embracing so that the last volution only is visible from the exterior; surface of the test smooth, the wall very finely but indistinctly perforate; aperture a narrow curved slit between the base of the inner face of the chamber and the previously formed whorl.

Diameter 0.17–0.40 mm.

Distribution.—Brady in the *Challenger* Report records this species from five stations in the North Pacific, the depths ranging from 345 to 2,750 fathoms. Picaglia records it from two stations of the *Vettor Pisani* and Bagg records it from seven *Albatross* stations in the vicinity of the Hawaiian Islands at depths ranging from 495 to 1,398 fathoms.

I have had numerous specimens of this species, notably from the *Nero* soundings from off the Hawaiian Islands and especially along the line of *Nero* soundings between Guam and Yokohama. These stations average about 1,500 fathoms, the shallowest being 392 and the deepest 1,660 fathoms, but two stations however were less than a thousand fathoms in depth. As a rule but very few specimens were present in the material from any one station in contrast to *P. obliquiloculata* which is often present in great numbers.

This species is one of the smallest of the family and one which may be overlooked on account of its size, but its other characters are such as to easily distinguish it.

PULLENIA QUINQUELOBA (Reuss).

Plate 13, fig. 2.

Nonionina quinqueloba Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 47, pl. 5, figs. 31*a*, *b*.

Pullenia quinqueloba H. B. Brady, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 712; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 617, pl. 84, figs. 14, 15.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 348, pl. 12, figs. 29*a*, *b*.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 43, figs. 22, 23.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1889, p. 487, pl. 11, fig. 29.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 373, pl. 19, figs. 28, 29.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 87, pl. 14, fig. 773; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 68.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 324, pl. 70, fig. 5.

Pullenia sphæroides (part) Parker and Jones, Philos. Trans., vol. 155, 1865, p. 368, pl. 17, fig. 53.

Description.—Test bilaterally symmetrical, biconvex, composed of numerous chambers arranged in an involute coil, five chambers usually being present in each coil, compressed laterally, peripheral edge broadly rounded; surface smooth, sutures somewhat compressed; aperture a long, narrow, curved slit at the base of the inner face of the chamber.

Diameter, 0.50–0.75 mm.

Distribution.—This species seems to be the least common of the three. Brady records it from two *Challenger* stations in the North Pacific, 224 in 1,850 fathoms and 241 in 2,300 fathoms. Goës records it from the western Pacific in 1,100–1,200 fathoms. I have had it from several stations, off the Galapagos Islands, in 1,379 fathoms, off the Hawaiian Islands, and from several *Nero* soundings, especially between Guam and Yokohama, but never in any considerable numbers.

PULLENIA OBLIQUILOCULATA Parker and Jones.

Plate 10, fig. 3; plate 12, figs. 2, 3.

Pullenia obliquiloculata PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 368, pl. 19, figs. 4*a*, *b*.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 294; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 618, pl. 84, figs. 16–20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 372, pl. 13, figs. 62–64.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 68.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 324, pl. 70, fig. 6.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 692.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.

Description.—Test obliquely nautiloid, subglobular, inequilateral, outer volution only visible, consisting of about five chambers, chambers inflated, sutures somewhat depressed; wall smooth; aperture a long, narrow, curved slit at the inner margin of the chamber.

Diameter, 0.50–0.90 mm.

Distribution.—This has proved to be one of the most common and widely distributed species of the North Pacific. Brady recorded it from four *Challenger* stations in the North Pacific ranging in depth from 345 to 2,100 fathoms. Goës records its occurrence in the western Pacific and Bagg found it in material from ten *Albatross* stations off the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms.

I have records of the occurrence of this species at seventy-five *Nero* stations between Guam and Yokohama and it has occurred also at numerous *Albatross*, *Nero*, and *Tuscarora* stations well scattered over the area. The depths have a range from 268 to 2,175 fathoms.

This species is the only one of the genus which has been found as a pelagic form. It is noteworthy that the pores of this species are much larger than those of the other two.

Family 9. NUMMULITIDAE.

Test calcareous, perforate, the chambers usually numerous, arranged in a spiral, either umbilicate or completely involute, surface variously ornamented; chamber walls in the higher forms with secondary canal system.

This family includes some of the largest and most complex of the Foraminifera and also from a paleontological viewpoint some of the most important rock builders. As a rule the largest species are characteristic of shallow tropical waters, especially of coral reefs. As such they are not common in the material which I have had available for this paper. However certain isolated regions as the Hawaiian Islands, Guam, and the southern tip of Japan have given records for most of the tropical species and the smaller colder water species of *Nonionina* and *Polystomella* have often been found in considerable numbers.

The higher genera of this family have been made the objects of critical researches by many writers and students of the Foraminifera, and their structure, although often complicated, is well known and abundantly illustrated.

Genus NONIONINA d'Orbigny, 1826.

Nautilus (part) WALKER and JACOB, Adam's Essays, Kanmacher's Ed., 1798, p. 641.

Polystomella (part) DEFRANCE, Dict. Sci. Nat., vol. 32, 1824, p. 183.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 403.

Nonionina D'ORBIGNY (type, *N. umbilicatula* d'Orbigny=*N. pompilioides* (Fichtel and Moll)), Ann. Sci. Nat., vol. 7, 1826, p. 293.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 724.

Description.—Test composed of numerous chambers arranged to form a bilateral, nautiloid coil, the last formed volution usually embracing all the preceding ones; walls usually smooth, sometimes pitted, very finely perforated; aperture a narrow opening or row of openings at the base of the apertural face, between it and the preceding volution.

In *Nonionina* the skeleton of the test is simple with little trace of the supplementary test being developed. The aperture is usually simple but in some species shows a tendency to become a series of openings as in some of the higher forms. Usually the last formed coil completely embraces the previously formed ones, but the test may be umbilicate, exposing the earlier coils at the umbilicus. In some species there is a tendency more or less marked to form a star-shaped thickening at the umbilical region, extending outward along the sutures between the chambers.

NONIONINA DEPRESSULA (Walker and Jacob).

Plate 17, fig. 3.

"Nautilus spiralis utrinque subumbilicatus" WALKER and BOYS, Test. Min., 1784, p. 19, pl. 3, fig. 68.

Nautilus depressulus WALKER and JACOB, Adam's Essays, Kanmacher's Ed., 1798, p. 641, pl. 14, fig. 33.

Nonionina depressula PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 4, 1859, pp. 339, 341.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 725, pl. 109, figs. 6, 7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 229, pl. 43, fig. 25.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 427, pl. 19, figs. 38, 39.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 103, pl. 17, figs. 825, 826.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 121, pl. 1, fig. 20.—WRIGHT, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 23.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, 1904, p. 12, pl. 3, fig. 6.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 599.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 12, pl. 4, fig. 8; vol. 54, No. 16, 1910, p. 29.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 88, pl. 26, figs. 16*a–c*; pl. 28, figs. 7, 8.

Nonionina asterizans, var. *depressula* Parker and Jones, Intr. Foram., Appendix, 1862, p. 310.

Polystomella crispa, var. (*Nonionina*) *depressula* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 403, pl. 14, fig. 39*a*, *b*.

Description.—Test rounded in side view, ten to twelve chambers visible in the last-formed volution, in apertural view with parallel sides and broadly rounded angles, narrow, about 3½ times as long as broad; very slightly if at all depressed at the umbilicus; chambers somewhat inflated and the sutures correspondingly depressed giving a lobulated periphery; umbilical region with a slight tendency toward filling in of shell tissue and a slight trace of stellate extension of this material outward along the sutures; aperture a narrow, arched slit.

Diameter, 0.40–0.50 mm.

Distribution.—The only previous records of this species in the North Pacific are those given by Bagg, *Albatross* stations D 4025 in 275–368 fathoms, H 4430 in 1,544 fathoms, H 4440 in 1,259 fathoms, and H 4566 in 572 fathoms, all off the Hawaiian Islands. I have had material from *Albatross* station D 4974 in 905 fathoms, bottom temperature 36.6° F. off Japan, and from the following *Nero* stations between Japan and Guam, 1081 in 1,900 fathoms, 1184 in 1,542 fathoms, 1191 in 1,551 fathoms, 1295 in 1,415 fathoms, and 1,302 in 1,331 fathoms.

NONIONINA UMBILICATULA (Montagu).

Plate 17, fig. 1.

Nautilus umbilicatulus Montagu, Test. Brit., 1803, p. 191; Suppl., p. 78, pl. 18, fig. 1.

Nonionina umbilicatula Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 242, pl. 12, fig. 157.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 203, pl. 4, fig. 48.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 726, pl. 109, figs. 8, 9.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 19.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 426, pl. 19, figs. 36, 37.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 103, pl. 17, fig. 823.—Chapman, Proc. California Acad. Sci., ser. 3 (Geol.), vol. 1, 1900, p. 256, pl. 30, fig. 15.—Millett, Journ. Roy. Micr. Soc., 1904, p. 600.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 15.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 90, pl. 27, figs. 4–6.

Nonionina umbilicata Terquem, Mém. Soc. géol. France, ser. 3, vol. 2, mem. iii, 1882, p. 42, pl. 2, fig. 7.

Description.—Test composed of numerous chambers, deeply umbilicate, in face view slightly tapering, broadest at the latest formed portion of the coil, about twice as long as broad, the periphery broadly rounded; surface deeply and prominently pitted, sutures tending to become limbate; aperture a very narrow curved opening at the base of the apertural wall of the chamber.

Diameter, 0.50–0.70 mm.

Distribution.—This species is recorded by Brady in the *Challenger* Report at four stations 214 in 500 fathoms, 224 in 1,850 fathoms, 241 in 2,300 fathoms, and 253 in 3,125 fathoms. Goës records it from two *Albatross* stations in the western Pacific, D 3431 in 995 fathoms and D 3375 in 1,201 fathoms, one specimen at each station. Bagg records it from two *Albatross* stations, H 4508 in 495 fathoms and H 4555 in 1,398 fathoms off the Hawaiian Islands.

In the material I have examined this has proved to be the most common species of the genus. It has occurred at *Albatross* stations D 3603 in 1,771 fathoms in Bering Sea, H 4878 in 84 fathoms and D 4970 in 500 fathoms, bottom temperature 39.1° F., both off Japan. It was taken at *Alert* station 1169 in 2,113 fathoms, lat. 21° 00′ 30″ N.; long. 142° 34′ 00″ E. Near Guam it was found at two *Nero* stations 990 in 859 fathoms and 1464 in 891 fathoms. Between Yokohama and Guam it occurred at a large number of stations ranging in depth from 901 to 2,250 fathoms.

This is the commonest umbilicate species as far as the North Pacific records show. It may be distinguished from the following species most easily in face view, which in this species is narrow and in *N. pompilioides* is broad.

NONIONINA POMPILIOIDES (Fichtel and Moll).

Plate 17, fig. 2.

"Nautilus Melo" SOLDANI, Testaceographia, vol. 2, 1798, p. 38, pl. 8, figs. *ZZ. A, B, C.*

Nautilus pompilioides FICHTEL and MOLL, Test. Micr., 1803, p. 31, pl. 2, figs. *a–e*,

Nonionina pompilioides PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 18, pl. 3, fig. 98; ser. 4, vol. 8, 1871, p. 246, pl. 12, fig. 158.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 204, pl. 4, fig. 49.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 727, pl. 109, figs. 10, 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 426, pl. 19, figs. 32, 33.—CHAPMAN, Proc. California Acad. Sci., ser. 3 (Geol.), vol. 1, 1900, p. 256, pl. 30, fig. 16.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 601.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.

Description.—Test composed of numerous chambers, slightly umbilicate, last volution of about seven chambers, in face view slightly tapering, broadest at the latest formed portion of the coil, slightly longer than broad, the periphery very broadly rounded; surface prominently pitted, sutures slightly limbate; aperture a narrow, curved opening at the base of the apertural face of the chamber forming nearly a semicircle, with a definite lip thickening.

Diameter, 0.50–0.80 mm.

Distribution.—Brady records this species from two *Challenger* stations in the North Pacific in 1,850 and 2,250 fathoms. Bagg records it from *Albatross* station H 4567 in 1,307 fathoms off the Hawaiian Islands. I have had specimens from Holothurian stomachs taken at

Albatross station D 3603 in 1,771 fathoms in Bering Sea and D 4822 in 130 fathoms off Japan. It occurred at *Nero* stations 12 in 1,924 fathoms, 166 in 1,850 fathoms, and 189 in 1,813 fathoms between the Hawaiian and Midway Islands and at a large number of *Nero* stations between Guam and Japan at depths ranging from 1,321 to 2,250 fathoms.

This species is easily distinguished from *N. umbilicatula* by its much broader test in face view.

NONIONINA ORBICULARIS H. B. Brady.

Plate 15, fig. 2.

Nonionina orbicularis H. B. Brady, Denkschr. Akad. Wiss. Wien, vol. 43, 1881, p. 105, pl. 2, figs. 5*a*, *b;* Ann. Mag. Nat. Hist., ser. 5, vol. 8, 1881, p. 415, pl. 21, figs. 5*a*, *b;* Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 727, pl. 109, figs. 20, 21.—Millett, Journ. Roy. Micr. Soc., 1904, p. 600, pl. 11, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.

Nonionina depressula, var. *orbicularis* Madsen, Medd. Dansk. Geol. Forening, No. 2, 1895, p. 217, pl., fig. 7.

Description.—Test subglobular with ten or more chambers in the final volution, in face view broad, periphery very broadly rounded, almost flattened, umbilical region filled with shell material granular as is also the material of the umbilical portion of the slightly limbate sutures; wall fairly smooth, the periphery lobulated slightly; aperture a narrow slit at the base of the apertural face of the chamber, the lateral portions tending toward division by downwardly projecting tooth-like portions.

Diameter, 0.75–1.00 mm.

Distribution.—The only record for this species in the North Pacific is that of Bagg, *Albatross* station D 4566 in 572 fathoms off the Hawaiian Islands.

NONIONINA ASTERIZANS (Fichtel and Moll).

Plate 14, fig. 5.

Nautilus asterizans Fichtel and Moll, Test. Micr., 1803, p. 37, pl. 3, figs. *e–h*.

Pulvinulus asterizans Lamarck, Tab. Encycl. et Méthod., pt. 23, 1816, pl. 466, figs 10*a–d*.

Placentula asterizans Lamarck, Anim. sans Vert., 1822, p. 621, No. 2.

Nonionina asterizans Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 287, pl. 11, figs. 20, 21; ser. 3, vol. 5, 1860, p. 101, No. 1.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 217, pl. 4, fig. 78.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 728, pl. 109, figs. 1, 2.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 425, pl. 19, figs. 47, 48.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 14.

Polystomella crispa, var. (*Nonionina*) *asterizans* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 403, pl. 14, fig. 35; pl. 17, fig. 54.

Description.—Test with twelve or more chambers in the final volution, in face view narrow, periphery broadly rounded, about 2½ to 3 times as long as wide, surface pitted, umbilical region slightly excavated at the center, the rest filled with shell tissue of considerable extent as a central mass, thence extending outward along the sutures in a star-like mass, making up nearly one-third the diameter of the test; aperture simple, narrow, with a slightly thickened lip.

Diameter up to 1 mm.

Distribution.—This species has not previously been recorded from the North Pacific. The only material I have had came from *Albatross* station H 4857 in 324 fathoms, in Bering Sea. The specimens are not typical, but are here figured.

NONIONINA STELLIGERA d'Orbigny.

Plate 14, fig. 4; plate 15, fig. 4; plate 16, fig. 2.

Nonionina stelligera D'ORBIGNY, in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, Foraminifères, 1839, p. 128, pl. 3, figs. 1, 2.—H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 471, pl. 48, fig. 19; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 728, pl. 109, figs. 3–5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 425, pl. 19, fig. 44.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 104, pl. 17, figs. 827, 828.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 121, pl. 1, fig. 18.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 654, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 600.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 13, pl. 4, fig. 9; vol. 54, No. 16, 1910, p. 29.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1910, p. 89, pl. 27, figs. 7, 8.

Polystomella crispa, var. (*Nonionina*) *stelligera* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 404, pl. 14, figs. 40, 41.

Description.—Test with usually ten to twelve chambers in the last formed volution, in face view narrow, 3 to 3½ times as long as broad, sides nearly parallel, periphery broadly rounded, slightly lobulated, surface punctate, umbilical portion with a filling of shell tissue in radiating rays from the umbilical portion toward the periphery along the sutures, each ray widest near the middle and distinct from the others, almost no umbilical depression; aperture a semicircular, very narrow opening at the base of the apertural face of the chamber, simple.

Diameter 0.50–0.70 mm.

Distribution.—This species has not previously been recorded from the North Pacific. It has occurred at *Albatross* D 2806 in 1,379 fathoms off the Galapagos Islands.

There is considerable variation in this species as will be seen by referring to the various figures of the synonymy given above. It is perhaps most easily confused with *N. asterizans*.

NONIONINA BOUEANA d'Orbigny.

Plate 16, fig. 1.

Nonionina boueana D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 108, pl. 5, figs. 11, 12.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 729, pl. 109, figs. 12, 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 426, pl. 19, figs. 34, 35.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 104, pl. 17, fig. 829.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 337, pl. 79, fig. 5.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 8, 1900, p. 400, fig. 49; ser. 6, vol. 1, 1904, p. 13, pl. 3, fig. 11.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 602.

Description.—Test compressed, composed of twelve to fifteen chambers in the last formed volution, chambers much longer than broad, sutures much curved, in face view test about 2½ times as long as wide, periphery subacute, scarcely if at all lobulated; umbilical area filled with shell tissue, sutures limbate; surface nearly smooth, wall very finely punctate; aperture a narrow curved slit at the base of the apertural face of the chamber, simple.

Diameter 0.50–0.75 mm.

Distribution.—The only *Challenger* record which Brady gives is Hongkong harbor in 7 fathoms. Flint records it from the Gulf of Tokyo in 9 fathoms. I have had it from off the Hawaiian Islands, *Albatross* H 2917 in 2,615 fathoms. It has also occurred at D 4964 in 37 fathoms, bottom temperature 66.6° F. off Japan. From the *Nero* material it occurred at station 1237 in 613 fathoms off Yokohama, Japan, and 1444 in 2,175 fathoms between Yokohama and Guam.

This is a rather characteristic species with its numerous chambers in a rapidly increasing width of volution and peculiar umbilical region.

NONIONINA SCAPHA (Fichtel and Moll).

Plate 15, fig. 1; plate 16, figs. 3, 4.

Nautilus scapha FICHTEL and MOLL, Test. Micr., 1803, p. 105, pl. 19, figs. *d–f*.

Nonionina scapha PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 102, No. 4.—H. B. BRADY, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865, p. 106, pl. 12, figs. 10*a*, *b*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 730, pl. 109, figs. 14, 15, and 16?—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 20.—WOODWARD and THOMAS, Geol. Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 48, pl. E, figs. 35, 36.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 424, pl. 19, figs. 43, 44.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 104, pl. 17, fig. 830.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 121, pl. 1, fig. 23.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 337, pl. 80, fig. 1.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, 1904, p. 12, pl. 3, fig. 4; pl. 13, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 601.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 13; vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 13.—BAGG, Bull. U. S. Geol. Surv. No. 513, 1912, p. 88, pl. 27, figs. 1–3.

Polystomella crispa, var. (*Nonionina*) *scapha* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 404, pl. 14, figs. 37, 38; pl. 17, figs. 55, 56.

Description.—Test somewhat compressed, composed of about ten chambers in the last formed volution, chambers rapidly increasing in length as added, especially in the adult test; chambers in front view broadest near the proximal end gradually tapering to the rounded periphery, earlier half of coil much narrower, whole test in face view a little more than twice as long as wide; surface smooth, punctate; aperture a narrow slit at the base of the apertural face, simple.

Diameter about 0.50 mm.

Distribution.—Brady records this species from three North Pacific stations in from 7–345 fathoms, the last being off Japan on the *Hyalonema*-ground. Flint records it from *Albatross* station D 2805 in 51 fathoms in Panama Bay and from the Gulf of Tokyo in 9 fathoms. Bagg records it from five *Albatross* stations off the Hawaiian Islands, D 4000 in 104–213 fathoms, D 4025 in 275–368 fathoms, H 4440 in 1,259 fathoms, H 4567 in 1,307 fathoms and H 4696 in 367 fathoms.

From the *Nero* material I have this species from station 1160 in 1,907 fathoms and 1237 in 613 fathoms. From the *Albatross* material I have had it from D 3603 in 1,771 fathoms in Bering Sea and from material from Holothurian stomachs, D 3608 in 276 fathoms. It also occurred off the Galapagos Islands, D 2806 in 1,379 fathoms. Off Japan it occurred at *Albatross* H 4878 in 84 fathoms, bottom temperature 51.9° F., D 5054 in 282 fathoms, bottom temperature 45.3° F., D 5056 in 258 fathoms, bottom temperature 46° F. and D 5085 in 622 fathoms, bottom temperature 37.8° F.

There seems to be either considerable variation in this species or else a number of forms included under a single name. The amount of material is not sufficient to determine the limits of variation.

NONIONINA TURGIDA (Williamson).

Plate 15, fig. 3.

Rotalina turgida WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 50, pl. 4, figs. 95–97.

Nonionina turgida H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 474, No. 91; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 731, pl. 109, fig. 17–19.—TERQUEM, Bull. Soc. Zool. France, vol. 11, 1886, p. 331, pl. 11, figs. 7, 8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 425, pl. 19, figs. 45, 46.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 602.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 13; vol. 54, No. 16, 1910, p. 29.

Polystomella crispa, var. (*Nonionina*) *turgida* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 405, pl. 17, figs. 57*a–c*.

Description.—Test composed of about ten chambers in the last formed volution, very rapidly increasing in size as added, the last formed chamber in the adult often making up nearly one-half the visible test and often at one side instead of bilaterally placed, in face view about twice as long as wide, the last formed chamber making up the larger part of the test, broadest at its base and thence gradually tapering to the subacute periphery, very slightly lobulated; wall smooth, punctate; aperture a narrow curved opening at the base of the apertural face, simple.

Length 0.40–0.55 mm.

Distribution.—The only North Pacific record for this species is that of Brady in the *Challenger* Report, off the coast of Japan on the *Hyalonema*-ground in 345 fathoms.

Genus POLYSTOMELLA Lamarck, 1822.

Nautilus (part) LINNÆUS, Syst. Nat., ed. 12, 1767, p. 1162.

Polystomella LAMARCK (type, *Polystomella crispa* (Linnæus)), Anim. sans Vert., vol. 7, 1822, p. 625.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 731.

Description.—Test composed of numerous chambers, arranged in a regular, bilaterally symmetrical, nautiloid spire, the chambers extending back to the umbilical region so that only the last formed chamber is visible, chambers either inflated with depressed sutures bridged across at regular intervals or the sutures may be limbate and the processes form a regular series of elevated ridges connecting the sutures; aperture either a simple opening at the base of the apertural face of the chamber or subdivided into a series of openings.

There is a considerable range of development seen in the various species of this genus from the simple species such as *P. striatopunctata* to the more complex *P. crispa*. In the higher species there is a supplemental skeleton to the test which is provided with a rather complex system of internal canals. Of these there are two spiral canals, one at either side of the test connecting with the meridional canals which lie in the septal depressions between the chambers and connect with the exterior by short tubes opening upon the septal lines. These are best seen in *P. arctica* and *P. sibirica,* the latter of which is here figured. Where the umbilical portion is filled with a secondary shell material as in *P. craticulata* this portion is filled with straight canals leading to the interior. The best figures of the internal structure are those given by Carpenter.

There is an interesting development in the species of this genus and corresponding distribution. The arctic species are decidedly different in many ways from the species which are so characteristic of tropical coral reefs.

POLYSTOMELLA STRIATO-PUNCTATA (Fichtel and Moll).

Plate 18, fig. 2.

Nautilus striato-punctatus Fichtel and Moll, Test. Micr., 1803, p. 61, pl. 9, figs. *a–c*.

Polystomella striato-punctata Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 103, No. 6.—Terrigi, Atti Accad. Pont. Nuovi Lincei, ann. 33, 1880, p. 216, pl. 4, figs. 73, 74.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 733, pl. 109, figs. 22, 23.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 17.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 433, pl. 19, figs. 49, 50.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 101, pl. 17, figs. 815 (part) 822.—Morton, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 122, pl. 1, fig. 19.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899) p. 337, pl. 80, fig. 2.—Wright, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 24.—Millett, Journ. Roy. Micr. Soc., 1904, p. 602.—Rhumbler, Zool. Jahrb., Abteil. Syst., vol. 24, 1906, p. 73, pl. 5, figs. 61, 62.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—Cushman, Proc. Boston Soc. Nat. Hist., vol. 34, 1905, p. 31, pl. 5, fig. 4.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 14, pl. 4, fig. 10; pl. 5, figs. 1, 2; vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 16.—Bagg, Bull. U. S. Geol. Surv., No. 513, p. 92, pl. 27, figs. 10–12.

Description.—Test composed of about 10 chambers in the last formed volution, in face view about 2½ times as long as wide, periphery broadly rounded, usually slightly depressed at the umbilicus: periphery slightly lobulated, chambers somewhat inflated, septal lines with regular bridging: aperture a nearly semicircular, narrow opening, sometimes showing traces of division into a series of openings.

Diameter, 0.50–0.70 mm.

Distribution.—In the North Pacific Brady records this species from a single *Challenger* station, Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. Bagg records it from one *Albatross* station D 4174 in 735–865 fathoms. Rhumbler records it from Chatham Island and Laysan. I have material from Hongkong; from *Nero* station 1311 in 1,503 fathoms; from off Alaska; from *Albatross* station 3603 in 1,771 fathoms in Bering Sea, abundant. It also occurred in material taken from Holothurian stomachs at *Albatross* D 3608 in 276 fathoms in Bering Sea.

There seems to be a number of forms which are included under this species and a critical study of a large amount of material would doubtless show some definite forms. I have not had sufficient material of this species to make any such comparisons.

POLYSTOMELLA SUBNODOSA (Münster).

Plate 14, fig. 8.

Robulina subnodosa MÜNSTER, Neues Jahrb. für Min., 1838, p. 391, pl. 3, fig. 61.
Polystomella subnodosa REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855, p. 240, pl. 4, fig. 51*a*, *b*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 734, pl. 110, fig. 1*a*, *b*.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 102, pl. 17, figs. 817–819.—FORNASINI, Rend. Accad. Sci. Ist. Bologna, vol. 2, 1897, pl. 1, fig. 12.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 604.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 16, pl. 5, fig. 6; vol. 54, No. 16, 1910, p. 30.—BAGG, Bull. U. S. Geol. Survey, No. 513, 1912, p. 92, pl. 28, figs. 12*a*, *b*.

Description.—Test composed of about 12 chambers in the last formed volution, in face view about 2½ times as long as wide, the periphery angled with a blunt keel, periphery very slightly if at all lobulated, umbilical region umbonate, septal lines depressed and evenly bridged: aperture an arched narrow opening at the base of the apertural face.

Diameter about 0.60 mm.

Distribution.—The only previously recorded station for this species is that given by Bagg, *Albatross* H 4508 in 495 fathoms. I have had specimens collected in the Inland Sea of Japan, and from *Albatross* D 4875 in 59 fathoms off Japan in the eastern channel of Korea Strait. It also occurred at D 3501 in 688 fathoms in Bering Sea.

This makes a rather peculiar distribution for this species.

POLYSTOMELLA CRISPA (Linnaeus).

Plate 18, fig. 1.

"Cornu Hammonis orbiculatum" PLANCUS, Conch. Min., 1739, p. 10, pl. 1, fig. 2.
Nautilus crispus LINNÆUS, Syst. Nat., ed. 12, 1767, p. 1162.
Polystomella crispa LAMARCK, Anim. sans Vert., vol. 7, 1822, p. 625, No. 1.—D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 125, pl. 6, figs. 9–14.—WILLIAMSON, Trans. Micr. Soc. London, vol. 2, 1849, p. 159, pl. 28; Rec. Foram. Great Britain, 1858, p. 40, pl. 3, figs. 78–80.—CARPENTER, Intr. Foram., 1862, p. 278, pl. 16, figs. 4–6.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 399, pl. 14, fig. 24; pl. 17, figs. 61*a*, *b*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 736, pl. 110, figs. 6, 7.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 9, 1893, p. 216, pl. 4, fig. 3.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 432, pl. 20, figs. 20, 21.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 102, pl. 17, figs. 820, 821.—LISTER, Philos. Trans., vol. 186, 1895, p. 414, pl. 6, figs. 1–3, 5–12; pl. 7, figs. 13–27; pl. 8, figs. 28–32.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 338, pl. 80, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 603, pl. 11, fig. 2.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 15; vol. 54, No. 16, 1910, p. 30.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 90, pl. 27, figs. 13–20; pl. 28, figs. 1–6.

Description.—Test composed of twenty or more chambers in the last formed volution, in face view about twice as long as wide, lenticular, widest at the middle, keeled with sharp angled periphery, not at all lobulated; surface with the reticulated portion larger than the septal lines; umbilical region umbonate, filled with clear shell material, usually with a few pores: aperture an angled narrow opening, V-shaped, divided into several secondary openings.

Diameter up to 1 mm.

Distribution.—Brady in the *Challenger* Report gives this species as found "as far north as Japan". I have found it a number of times in the material I have examined. It occurred in material collected in Gaspar Straits by Captain Rodgers of the U. S. Exploring Expedition, from Hongkong, 9 fathoms: from Cagayan, Philippine Islands, collected by Dr. E. A. Mearns. In the *Nero* material it occurred at station 990 in 859 fathoms off Guam and station 1237 in 613 fathoms off Yokohama, Japan. In the *Albatross* material it occurred at station D 4922 in 60 fathoms, D 4916 in 361 fathoms, D 4891 in 181 fathoms and D 4970 in 500 fathoms.

POLYSTOMELLA MACELLA (Fichtel and Moll).

Plate 18, fig. 3.

Nautilus macellus, var. α, Fichtel and Moll, Test. Micr., 1803, p. 66, pl. 10, figs. *e–g*.

Polystomella macella Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 104, No. 8.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 737, pl. 110, figs. 8, 9, 11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 432, pl. 20, figs. 22, 23.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 15, pl. 5, fig. 4; vol. 54, No. 16, 1910, p. 30.

Description.—Test compressed, with about twenty chambers in the last-formed volution, in face view 3 to 5 times as long as wide, keeled with a sharp-angled periphery, sometimes slightly lobulated at the periphery, surface with the reticulated portion making up most of the area, the septal lines narrow, umbilical region slightly depressed, porous, aperture divided into a number of smaller openings.

Diameter up to 0.85 mm.

Distribution.—Bagg records this species from two *Albatross* stations off the Hawaiian Islands, D 4000 in 104–213 fathoms and H 4430 in 1,544 fathoms. I have seen it in the material I have examined from the Gulf of Tokyo, in 9 fathoms, *Albatross* stations D 4825 in 120 fathoms and D 4970 in 500 fathoms both off Japan and at *Nero* station 1306 in 1,208 fathoms between Yokohama and Guam.

POLYSTOMELLA CRATICULATA (Fichtel and Moll).

Plate 19, fig. 4.

Nautilus craticulatus Fichtel and Moll, Test. Micr., 1803, p. 51, pl. 5, figs. *h–k*.
Polystomella craticulata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 284, No. 3.—Carpenter, Intr. Foram., 1862, p. 279, pl. 16, figs. 1, 2.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 739, pl. 110, figs. 16, 17.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 433, pl. 20, figs. 24, 25.—Millett, Journ. Roy. Micr. Soc., 1904, p. 604.

Description.—Test subglobose, composed of as many as fifty chambers in the last formed coil; in face view broadly lenticular about 1½ times as long as wide, periphery bluntly rounded; umbilical region umbonate, filled with clear shell material for one-third or more of the diameter of the test, with large pores; remainder of surface reticulate; aperture a long, narrow opening subdivided into a number of pores.

Diameter up to 3.5 mm.

Distribution.—Brady records this species from three North Pacific *Challenger* stations, Chinese Sea, Hongkong Harbor in 7 fathoms and Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. The only material I have had was collected by Dr. E. A. Mearns from shore sands, Cebu, Philippine Islands.

This is distinctly a tropical shallow-water species, and a large and beautiful one. Very probably it is widely distributed in the shallow waters about the islands of the southern portion of the North Pacific, although material is not available.

POLYSTOMELLA SIBIRICA Goës.

Plate 19, fig. 1.

Polystomella sibirica Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 100, pl. 17, fig. 814.

Description.—Test broad, complanate, much compressed, made up of about 25 chambers in the last-formed volution; in face view about 3½ to 5 times as long as wide, sutural lines showing a double line of pores, umbilical region filled with clear shell material, porous; aperture a series of small pores in a V-shaped arrangement.

Diameter up to 4 mm.

Distribution.—This species was found at but one station, *Albatross* D 3600 in 156 fathoms in Bering Sea. At this station it was abundant and it probably has a general distribution in this region from which comparatively little material is available. It is a large and striking species.

Genus AMPHISTEGINA d'Orbigny, 1826.

Amphistegina D'ORBIGNY (type, *A. lessonii* d'Orbigny) Ann. Sci. Nat., vol. 7, 1826, p. 304.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 739.

Description.—Test spiral, lenticular, more convex on one side than the other, the last-formed volution usually covering the others, chambers with the alar projections on one side simple, divided on the other side by deep constrictions to form supplementary lobes; wall thickened near the umbilicus, usually smooth except near the aperture on the ventral side where it is usually papillose, no true secondary canal system developed; aperture on the ventral side at the base of the chamber, simple.

There are various forms of this genus but by the foregoing characters they may be distinguished. Occasionally there is some surface ornamentation but usually the wall is smooth. It is often very abundant in the shallow waters of the Tropics.

AMPHISTEGINA LESSONII d'Orbigny.

Plate 19, fig. 2.

Amphistegina lessonii D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 304, No. 3, pl. 17, figs. 1–4; Modèles, No. 98.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 34, pl. 3, fig. 92.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 740, pl. 111, figs. 1–7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 15.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 431, pl. 20, figs. 18, 19.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 338, pl. 82, fig. 4.—FORNASINI, Rend. Accad. Sci. Ist. Bologna, vol. 7, 1903, pl. 2, fig. 1.—SHERLOCK, Bull. Mus. Comp. Zoöl., vol. 38, 1903, p. 356, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 605.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, pt. 2, 1910, p. 294, pl. 53, fig. 6.

Description.—Test lenticular or more convex on one side than the other, surface smooth, composed of about 25 chambers in the last-formed volution which embraces the preceding ones, chambers on the dorsal side with the alar projections simple, on the ventral side divided by deep constrictions usually into two lobes, especially in the thicker varieties the test is papillose about the ventral margin of the aperture, aperture Rotaliform, simple.

Diameter up to 3 mm.

Distribution.—Brady does not record this species from the *Challenger* material of the North Pacific. Bagg records it from eleven *Albatross* stations in the vicinity of the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms.

Among the various lots of material I have had this species was very common in that from Gaspar Straits, from Cagayan, Philippines, collected by Dr. E. A. Mearns, *Alert* station 1177 in 23–118 fathoms and in Hongkong Harbor. It occurred at *Nero* station 201 in 1,033 fathoms and 209 in 82 fathoms off Midway Islands, station 990 in 859 fathoms off Guam, and stations 2031 in 1,624 fathoms, 2036 in 82 fathoms, and 2074 in 22 fathoms off the Hawaiian Islands. In the *Albatross* material it has occurred at H 2922 in 268 fathoms also off the Hawaiian Islands and D 4922 in 60 fathoms and H 4882 in 248 fathoms both off Blake Reef, Colnett or Vincennes Strait off southern Japan. This region from other species already recorded here has proved to be southern in its relations and a region at which many southern species seem to approach their northern limits on this coast.

This species is used at the present time to include various forms which may be distinct. Brady notes the fact that various forms occur and Bagg also found them. A study of recent tropical material should show something definite in regard to these specific or varietal forms.

Genus OPERCULINA d'Orbigny, 1826.

Nautilus (part) Gronovius, Zooph. Gron., 1781, p. 282.

Lenticulites (part) Defrance, Dict. Sci. Nat., vol. 25, 1822, p. 453.

Operculina d'Orbigny (Type, *O. complanata* Defrance), Ann. Sci. Nat., vol. 7, 1826, p. 281.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 742.

Description.—Test coiled, compressed, consisting of numerous chambers in three or four volutions, bilaterally symmetrical, and all visible from either side, not embracing, except in the early whorls, in face view very thin, usually thickest at the umbonal region; surface smooth or ornamented with bosses; aperture single at the base of the apertural wall of the chamber.

Carpenter[1] has given a very detailed account of the structure of this genus. The genus is characteristic, at least in the larger forms, of the warmer shallow seas. It is a characteristic genus of the earlier Tertiaries.

OPERCULINA COMPLANATA (Defrance).

Lenticulites complanata Defrance, Dict. Sci. Nat., vol. 25, 1822, p. 453.

Operculina complanata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 281, pl. 14, figs. 7–10; Modèles, No. 80.—Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 8, 1861, p. 229.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 743, pl. 112, figs. 3, 4, 5, 8.—Woodward and Thomas, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 175, pl. 4, fig. 35; vol. 3, 1893, p. 45, pl. E, fig. 37.—[?] Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 435, pl. 20, figs. 40–42.—Newton and Holland, Journ. Coll. Sci. Imp. Univ. Tokyo, 1902, p. 13, pl. 1, fig. 3, 5; pl. 3, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1904, p. 605.

Description.—Test much compressed, the early volutions somewhat embracing, later ones nonembracing, bilaterally symmetrical, chambers in the last formed whorl very numerous, periphery very thin, sometimes slightly keeled, sutures usually angled and sharply directed backward near the periphery, surface smooth; aperture a single opening at the base of the apertural face in addition to which there are numerous secondary openings in the chambers of the last whorl, appearing as large pores on the exterior.

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[1] Introd. Foram., 1862.

Diameter up to 8 or 10 mm.

Distribution.—The only record from the North Pacific for this typical form of the species has been that of Brady in the *Challenger* Report, coral reefs of Honolulu, 40 fathoms. I have found it in material collected in Gaspar Straits by Captain Rodgers of the North Pacific Exploring Expedition. The smooth form seems to be much less common than the following variety.

OPERCULINA COMPLANATA (Defrance), var. GRANULOSA Leymerie.

Plate 19, fig. 3.

Operculina granulosa Leymerie, Mém. Soc. Géol. France, ser. 2, vol. 1, 1846, p. 359, pl. 13, figs. 12*a*, *b*.—[?] Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 435, pl. 20, figs. 36, 37, 43.

Operculina complanata (Defrance), var. *granulosa* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 743, pl. 112, figs. 6, 7, 9, 10.—Woodward and Thomas, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 176, pl. 4, fig. 36.—Newton and Holland, Journ. Coll. Sci. Imp. Univ. Tokyo, vol. 17, 1902, p. 14, pl. 2, fig. 4; pl. 3, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1904, p. 606.

Description.—Differing from the typical form in the character of the surface which is granular or papillose, especially on the earlier whorls, the papillæ being most frequent along the suture lines.

The varietal form seems to be much more common than the typical smooth form. Brady in the *Challenger* Report records it from the coral reefs of Honolulu in 40 fathoms. In the material I have examined it was common in Gaspar Straits; in 13 fathoms off Singapore, from *Alert* station 1177 in 23–118 fathoms and from *Albatross* station D 4922 in 60 fathoms. This last is the station from which *Heterostegina* was also found showing the southern character of the fauna at that station.

OPERCULINA AMMONOIDES (Gronovius).

Plate 14, fig. 7.

Nautilus ammonoides Gronovius, Zooph. Gron., 1781, p. 282, No. 1220.

Operculina ammonoides Parker and Jones, Intr. Foram., 1862, Appendix, p. 310.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 745, pl. 112, figs. 1, 2.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 434, pl. 20, figs. 38, 39.

Description.—Test small, somewhat embracing, the last formed whorl making up the greater part of the visible test with about twelve chambers in the whorl, sutures limbate, the intermediate portions of the surface depressed, the inner margin of the whorl often granulose, in face view about five times as long as wide; aperture simple.

Diameter about 0.5 mm.

Distribution.—The only North Pacific stations from which this species has been recorded are given by Brady in the *Challenger* Report, off the Philippines in 95 fathoms, Hongkong Harbor in 7 fathoms, south of Japan on the *Hyalonema* ground in 345 fathoms.

I have the species from *Albatross* station D 4970 in 500 fathoms off Japan.

Genus HETEROSTEGINA d'Orbigny, 1826.

Heterostegina D'ORBIGNY (type, *H. depressa* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 305.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 745.

Description.—Test compressed, especially the last-formed whorl, the early whorls often embracing and fairly thick, lenticular in side view; chambers numerous, subdivided into chamberlets by transverse partitions and visible from the exterior; secondary canal system developed and comparable to *Operculina;* aperture consisting of a row of pores on the outer face of the chamber, one pore for each of the chamberlets.

The chamberlets are not directly connected with one another in the same chamber but are connected by the previously formed apertures with the adjacent chamberlet of the previous chamber. Often the central portion of the test is decidedly thickened while the last-formed whorl is extremely thin.

The genus is characteristic of shallow water of the Tropics.

HETEROSTEGINA DEPRESSA d'Orbigny.

Plate 19, fig. 5.

Heterostegina depressa D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 305, No. 2, pl. 17, figs. 5–7; Modèles, No. 99.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 34, pl. 3, fig. 100.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 746, pl. 112, figs. 14–20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 433, pl. 20, figs. 34, 35.—CHAPMAN, Journ. Linn. Soc., Zool., vol. 28, 1900, p. 18, pl. 3, figs. 6, 7.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 606.—RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24, 1906, p. 74.

Description.—Test in section lenticular, early chambers embracing and thickened, later whorls thin, periphery with a thin keel, chambers subdivided into chamberlets by transverse partitions, the chamberlets near the interior border of the whorl being much larger than those of the peripheral portion, division apparent from the exterior.

Diameter up to 5 mm. or more.

Distribution.—The *Challenger* expedition obtained this species in the North Pacific from the Chinese Sea and from the Honolulu coral reefs in 40 fathoms. Bagg records it from one *Albatross* station near the Hawaiian Islands, H 4566 in 572 fathoms. Rhumbler records it from Laysan Island.

The only station at which I have had the species is *Albatross* D 4922 in Colnett or Vincennes Strait in 60 fathoms, bottom temperature 79.2° F. The bottom is given as coral in the records. This and the adjoining stations are those from which many southern species were found and where they apparently approach their northern limits in this particular region.

Genus NUMMULITES Lamarck, 1801.

Nummulites Lamarck (type, *N. laevigata* Lamarck), Anim. sans Vert., vol. 9, 1801, p. 101.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 747.

Description.—Test coiled, biconvex, usually bilaterally symmetrical, composed of numerous volutions. The chambers numerous and extending to the umbo, each volution completely inclosing the preceding ones, the periphery often keeled, aperture a simple V-shaped opening at the base of the apertural face of the chamber.

The genus *Nummulites* is almost entirely represented by fossil species but the genus still persists in the warmer seas of the Pacific in comparatively shallow water. Our recent species are much less complicated in their structure and smaller in size than the fossil ones.

NUMMULITES CUMINGII (Carpenter).

Plate 14, fig. 6.

Amphistegina cumingii Carpenter, Philos. Trans., 1859, p. 32, pl. 5, figs. 13–17.

Nummulites cumingii H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 749, pl. 112, figs. 11–13; woodcut, fig. 22.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 166.

Nummulites radiata Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 167.

Description.—Test composed of several whorls, with about 20 chambers in the last-formed whorl, lenticular in cross section, about 2½ times as long as wide, surface smooth, umbonal portion with sutures showing thickened bands at the surface, abruptly curved backward near the periphery, surface between the sutures often with conspicuous pores; aperture simple, V-shaped.

Diameter about 3 mm.

Distribution.—Brady records this species from the Chinese Sea and off the Philippine Islands in 95 fathoms. Bagg records it from four *Albatross* stations off the Hawaiian Islands, D 4000 in 104–213 fathoms, H 4476 in 438 fathoms, H 4566 in 572 fathoms, and H 4590 in 978 fathoms.

So far as I have observed in the material I have examined this species has occurred but once, *Nero* station 190 in 864 fathoms near Midway Islands. It should be noted, however, that most of the material I have had has come from deep water and little of it from shallow water in the Tropics where this species is mostly found.

There seems to be but one living species of this genus.

EXPLANATION OF PLATES.

Plate 1.

Fig. 1. *Chilostomella ovoidea.* × 40. Partial side view.
2. *Chilostomella ovoidea.* × 40. *a*, front view; *b*, apertural view.
3. *Chilostomella ovoidea.* × 50. Broken specimen showing relative size of chambers (after Brady).
4, 5. *Chilostomella ovoidea.* × 70. By transmitted light showing relations of interior chambers (after Brady).
6. *Allomorphina trigona.* × 60. (After Brady.)
7. *Allomorphina trigona.* × 60. (After Brady.)
8. *Allomorphina trigona.* × 100. Viewed by transmitted light (after Brady).

Plate 2.

Figures from photographs. × 30.

Fig. 1. *Globigerina æquilateralis*, apertural view.
2. *Globigerina æquilateralis*, front view.
3. *Globigerina æquilateralis*, side view.
4. *Globigerina sacculifera*, from above.
5. *Globigerina sacculifera*, from below.
6. *Globigerina sacculifera*, from side.
7. *Globigerina bulloides*, from above.
8. *Globigerina bulloides*, from side.
9. *Globigerina bulloides*, from below.

Plate 3.

Figures from photographs. × 30.

Fig. 1. *Globigerina helicina*, from below.
2. *Globigerina helicina*, from above.
3. *Globigerina conglobata*, from below.
4. *Globigerina conglobata*, from side.
5. *Globigerina conglobata*, from above.
6. *Globigerina rubra*, from above.
7. *Globigerina rubra*, from side.
8. *Globigerina rubra*, from side.
9. *Globigerina rubra*, from below.

Plate 4.

Figures from photographs. × 30.

Fig. 1. *Globigerina dubia*, from above.
2. *Globigerina dubia*, from side.
3. *Globigerina dubia*, from below.
4. *Globigerina inflata*, from above.
5. *Globigerina inflata*, from below.
6. *Globigerina inflata*, from side.
7. *Globigerina inflata*, from side.
8. *Globigerina inflata*, from side.

Plate 5.

Globigerina sacculifera. × 75. 1*a*, from above; 1*b*, same from below.

Plate 6.

Orbulina universa. × 50. (After Brady.)

Fig. 1. Specimen with spines;
  2–4. Specimens viewed by transmitted light showing *Globigerina*-like young within.
  5. Thick-walled specimen showing various layers of wall.

Plate 7.

Orbulina universa.

Fig. 1. Broken specimen showing early *Globigerina*-like chambers. × 75.
  2. Slightly irregular specimen showing large aperture and smaller pores, previously formed chamber still visible from the exterior. × 90.

Plate 8.

Hastigerina pelagica (after Brady).

Fig. 1. Living specimen. × 30.
  2. Specimen showing spines complete and sarcode. × 33.
  3, 4. Specimens from glycerine mounts. × 38.
  5–8. Dead and empty tests with broken spines. × 38.

Plate 9.

Living specimen of *Globigerina bulloides* with spines (after Brady).

Plate 10.

Fig. 1. *Globigerina conglobata*, in section. × 50. (After Brady.)
  2. *Sphæroidina dehiscens*, in section. × 50. (After Brady.)
  3. *Pullenia obliquiloculata*, in section. × 50. (After Brady.)
  4. *Globigerina sacculifera*, in section. × 50. (After Brady.)
  5. *Globigerina æquilateralis*, in section. × 50. (After Brady.)
  6. *Globigerina conglobata*, in section. × 50. (After Brady.)
  7. *Sphæroidina bulloides*, in section. × 50. (After Brady.)

Plate 11.

Fig. 1. *Candeina nitida.* × 75. *a*, from side; *b*, from above; *c*, from below.
  2. *Pullenia sphæroides.* × 75. *a*, from side; *b*, apertural view.
  3. *Orbulina universa.* × 180. Portion of surface.

Plate 12.

Fig. 1. *Sphæroidina bulloides.* × 66. *a*, apertural view; *b*, from above.
  2. *Pullenia obliquiloculata.* × 66. *a*, from above; *b*, apertural view.
  3. *Pullenia obliquiloculata.* × 66. *a*, from above; *b*, apertural view.

Plate 13.

Fig. 1. *Sphæroidina dehiscens.* × 55. *a*, from below; *b*, from above; *c*, from side.
  2. *Pullenia quinqueloba.* × 66. *a*, apertural view; *b*, side view.

PLATE 14.

Fig. 1. *Globigerina digitata.* × 50. Adult specimen.
2. *Globigerina digitata.* × 50. Adult specimen.
3. *Globigerina digitata.* × 50. Young specimen.
4. *Nonionina stelligera.* × 66. *a*, from side; *b*, apertural view.
5. *Nonionina asterizans.* × 66. *a*, from side; *b*, apertural view.
6. *Nummulites cumingii.* × 13. *a*, side view; *b*, apertural view.
7. *Operculina ammonoides.* × 33.
8. *Polystomella subnodosa.* × 133. *a*, front view; *b*, apertural view.

PLATE 15.

Fig. 1. *Nonionina scapha.* × 100. *a*, side view; *b*, front view.
2. *Nonionina orbicularis.* × 50. (After Brady).
3. *Nonionina turgida.* × 50. *a*, side view; *b*, front view. (After Brady).
4. *Nonionina stelligera.* × 100. *a*, side view; *b*, front view.

PLATE 16.

1. *Nonionina boueana.* ×130. *a*, side view; *b*, face view.
2. *Nonionina stelligera.* ×130. *a*, side view; *b*, face view.
3. *Nonionina scapha*, slightly umbilicate form. × 75. *a*, side view; *b*, face view.
4. *Nonignina scapha*, more typical form. × 75. *a*, side view; *b*, face view.

PLATE 17.

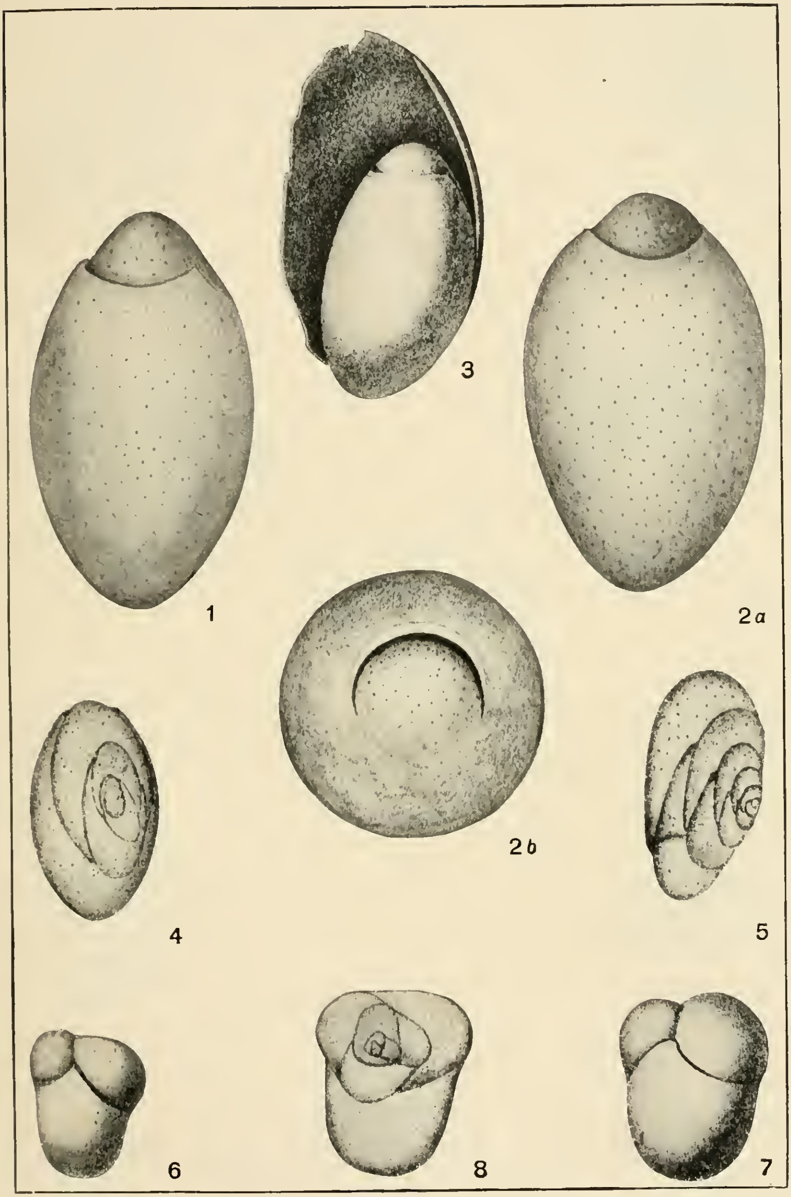
1. *Nonionina umbilicatula.* × 75. *a*, side view; *b*, face view.
2. *Nonionina pompilioides.* × 75. *a*, side view; *b*, face view.
3. *Nonionina depressula.* × 130. *a*, side view; *b*, face view.

PLATE 18.

Fig. 1. *Polystomella crispa.* × 30. *a*, side view: *b*, face view.
2. *Polystomella striato-punctata.* × 66. *a*, side view; *b*, face view.
3. *Polystomella macella.* × 66. *a*, side view; *b*, face view.

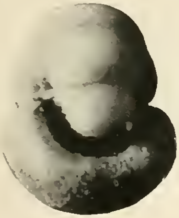
PLATE 19.

Fig. 1. *Polystomella sibirica.* × 30. *a*, side view; *b*, face view.
2. *Amphistegina lessonii.* × 30.
3. *Operculina complanata*, var. *granulosa.* × 18.
4. *Polystomella craticulata.* × 35. *a*, side view; *b*, face view.
5. *Heterostegina depressa*, young specimen. × 35.



Chilostomellidæ of North Pacific Ocean.

For explanation of plate see page 41.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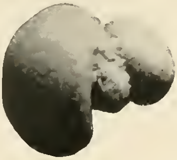
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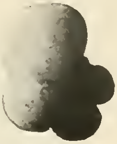
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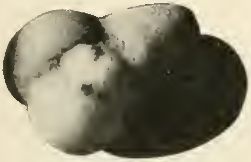
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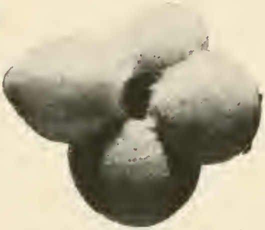
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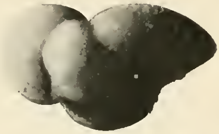
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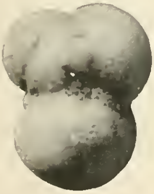
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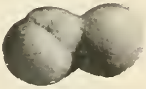
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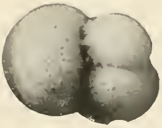
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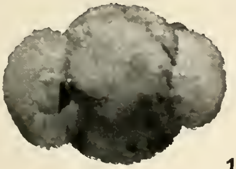

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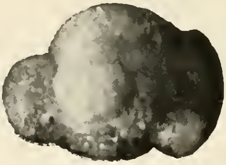

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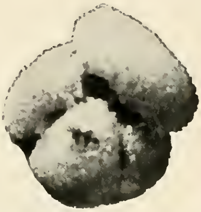

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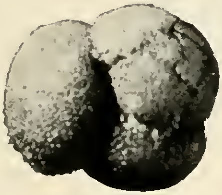

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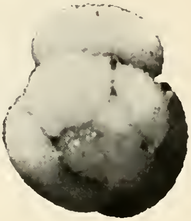

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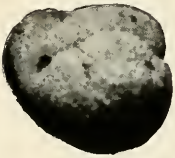

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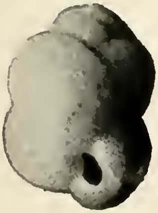

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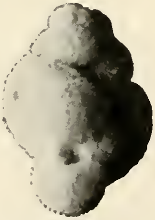

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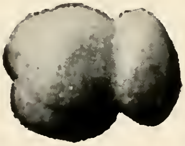

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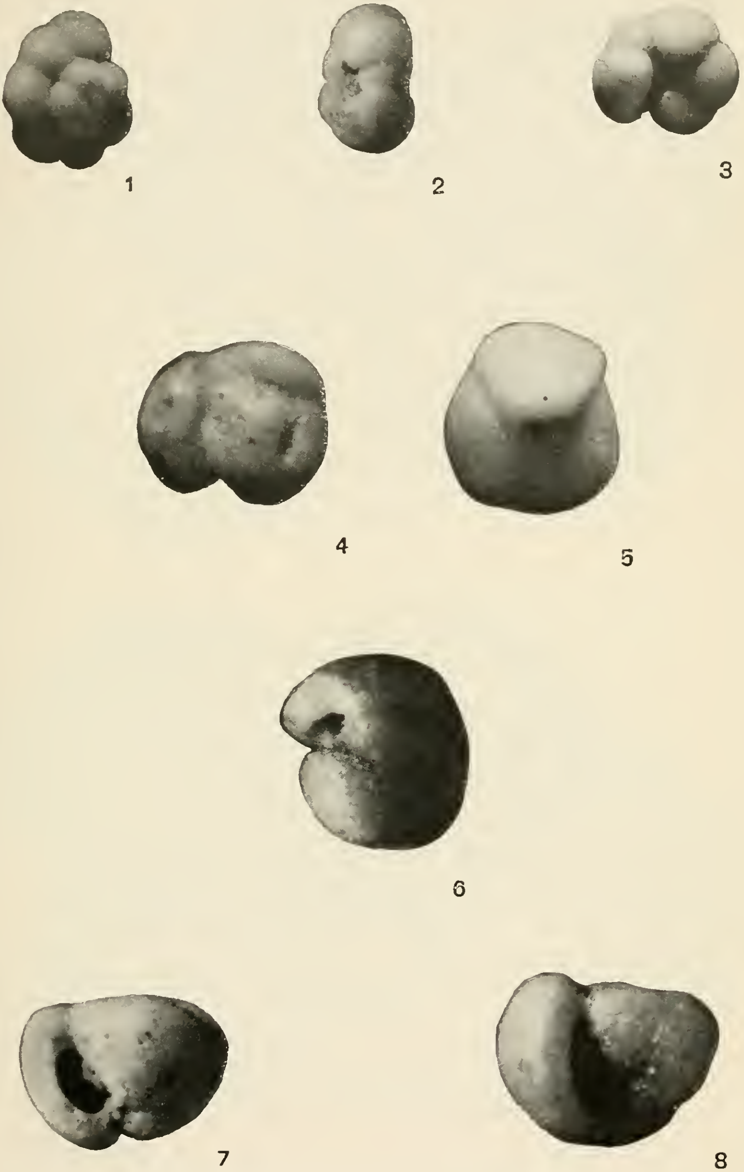

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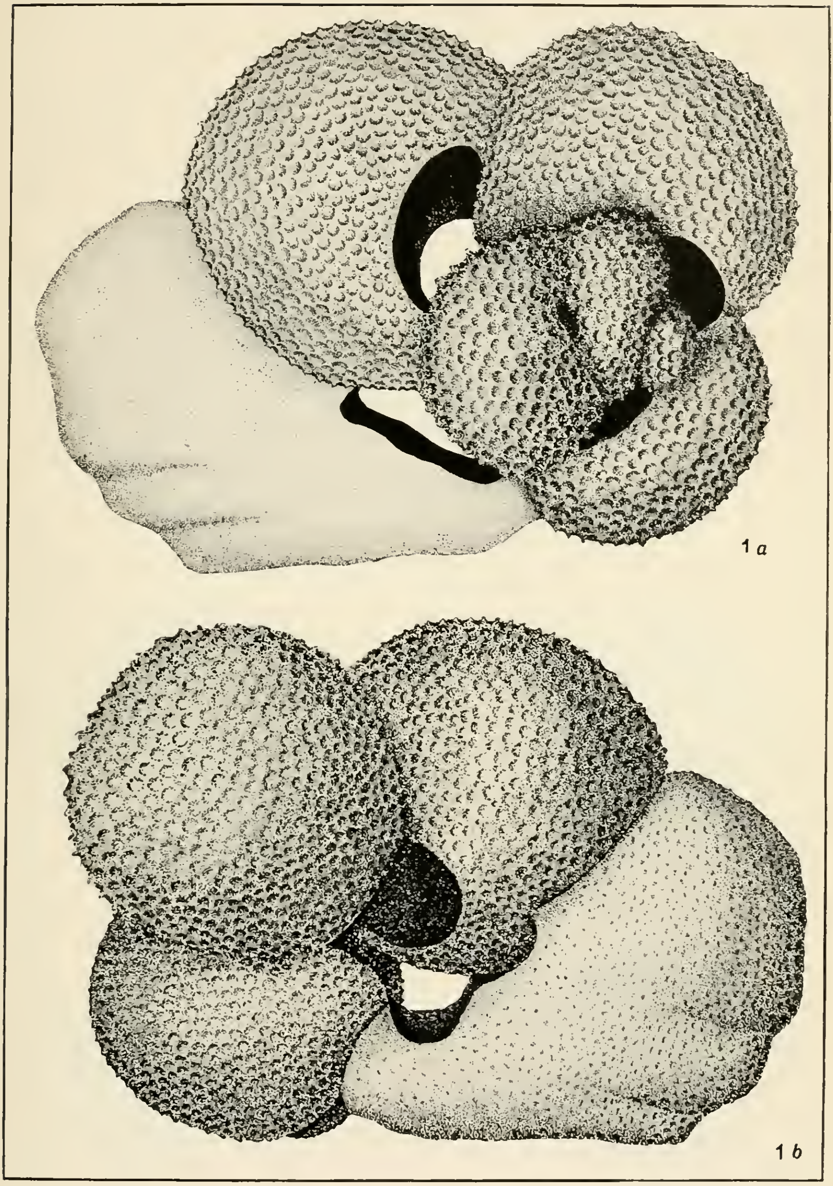

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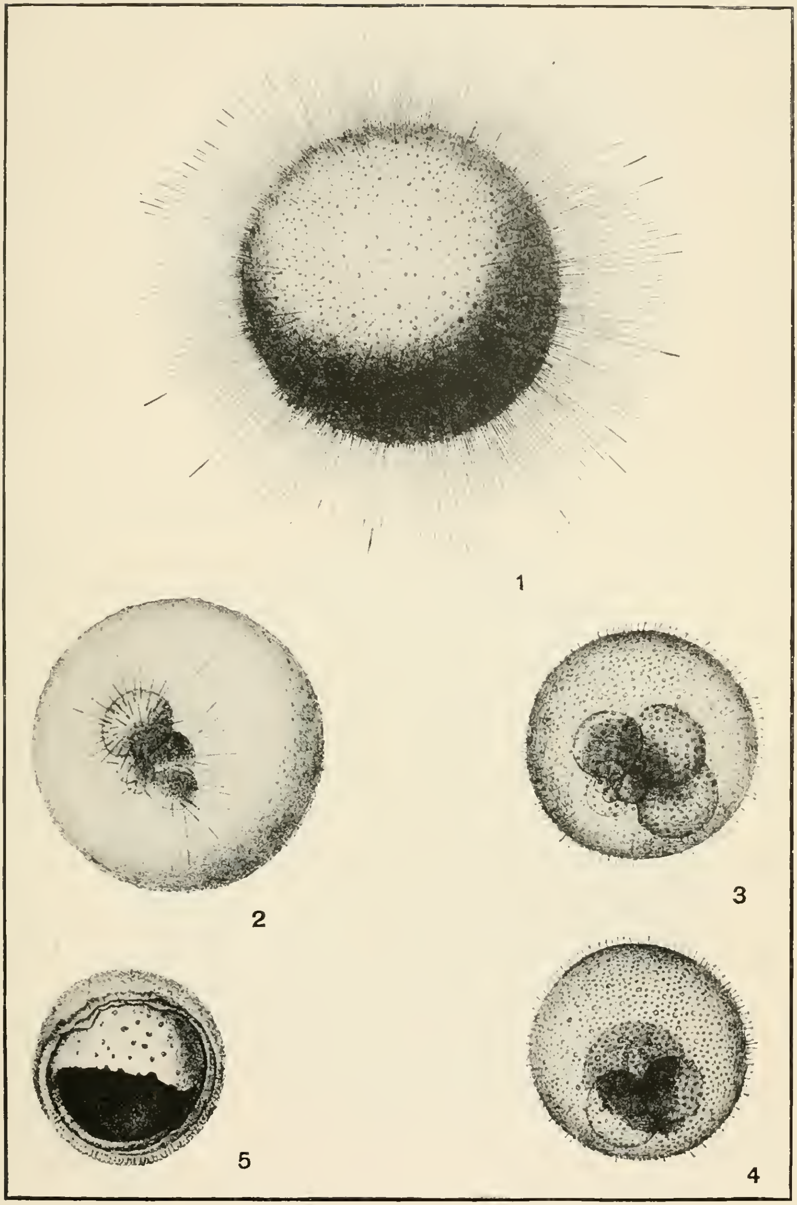

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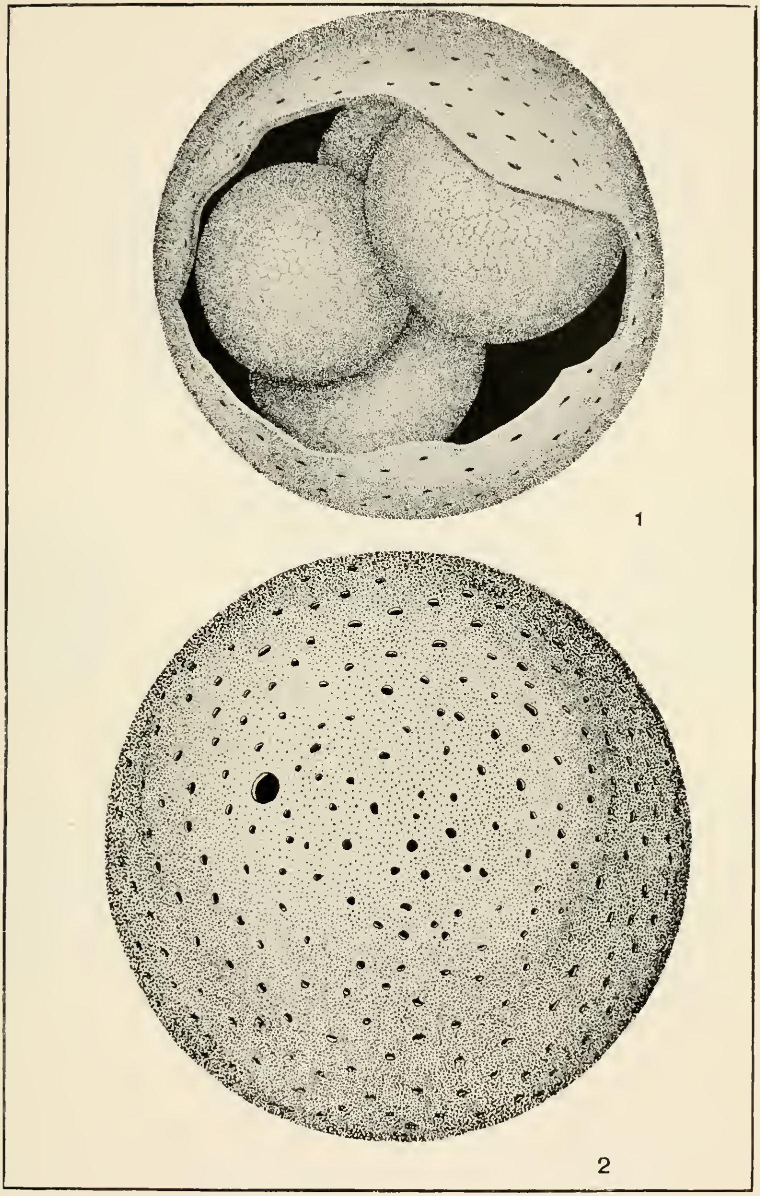

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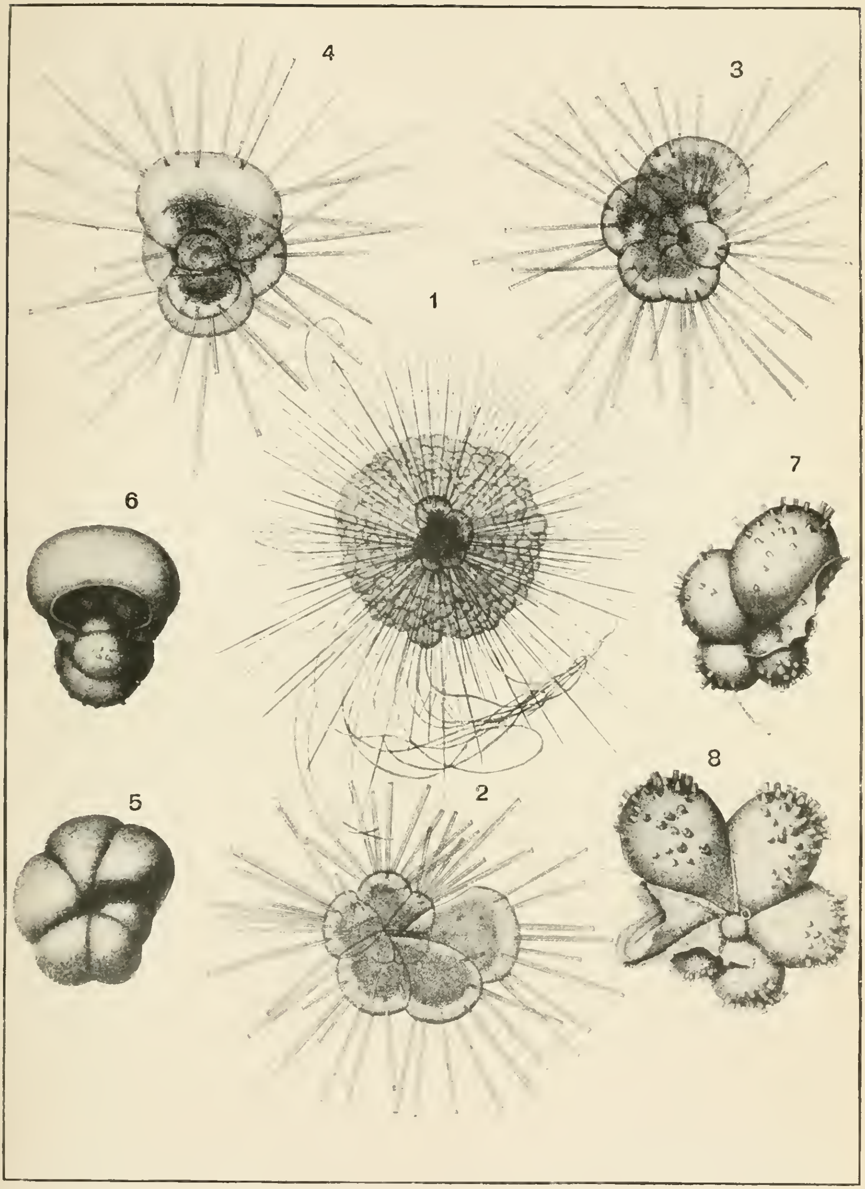

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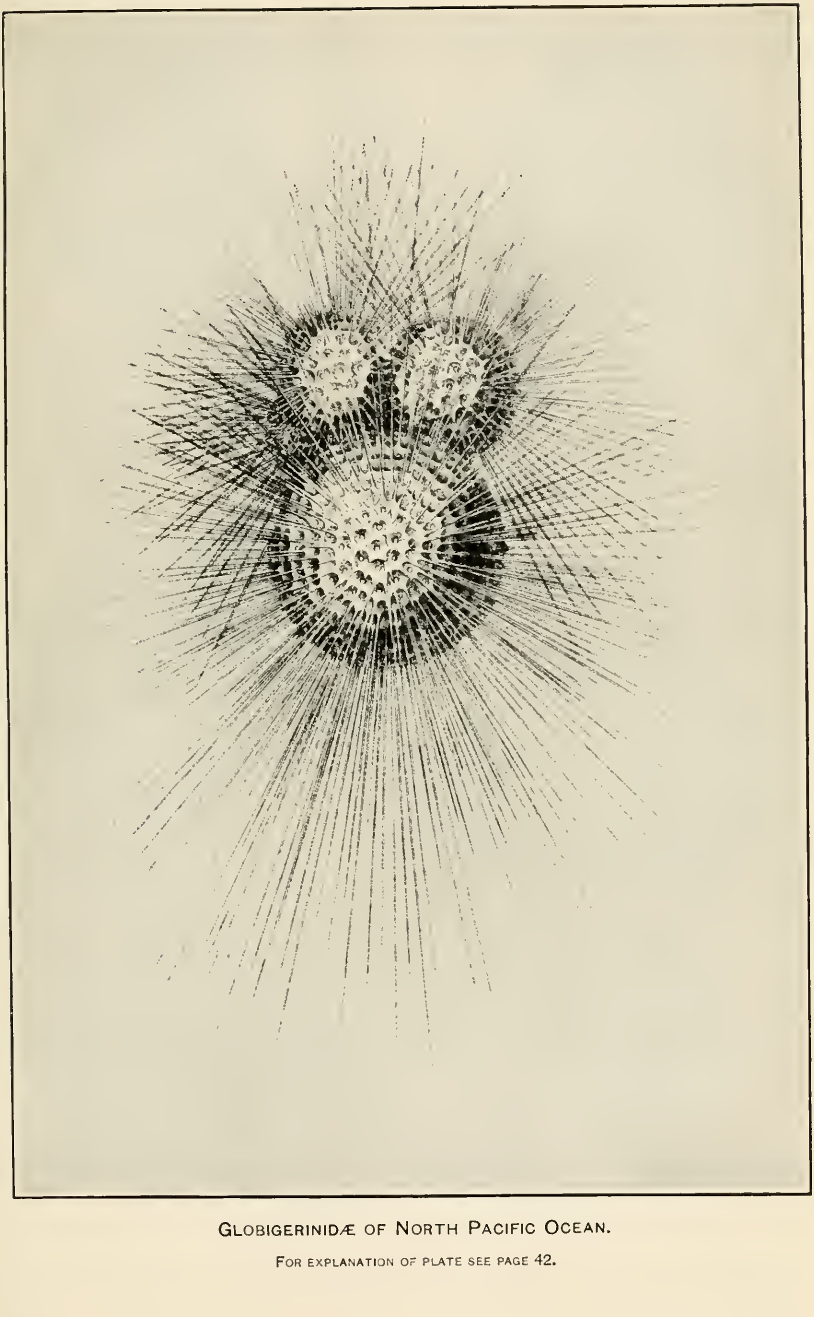

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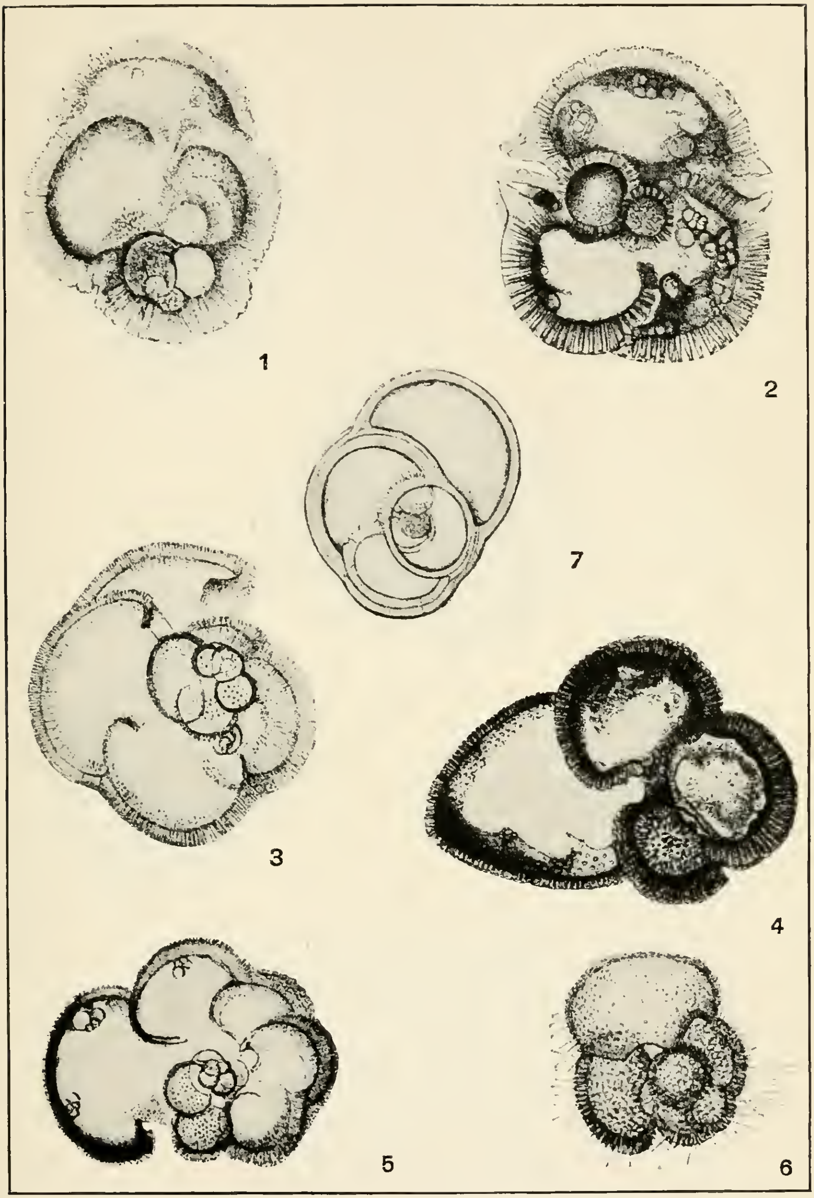

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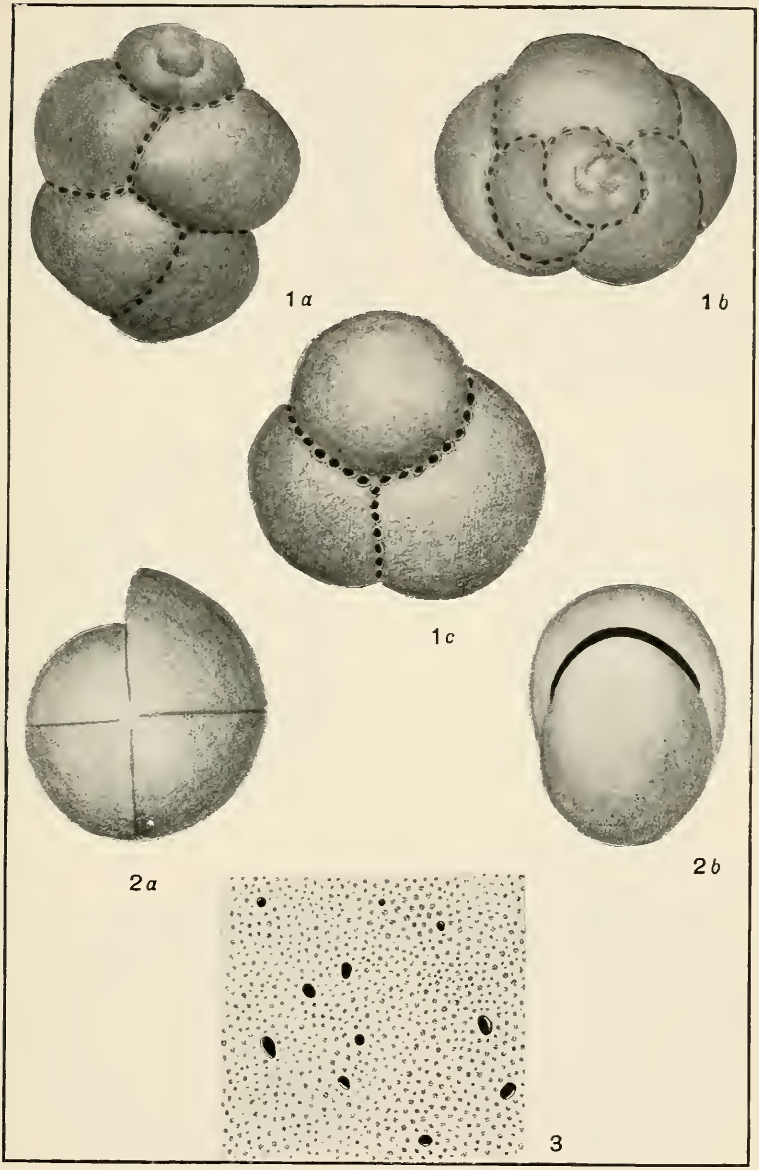
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2b
3

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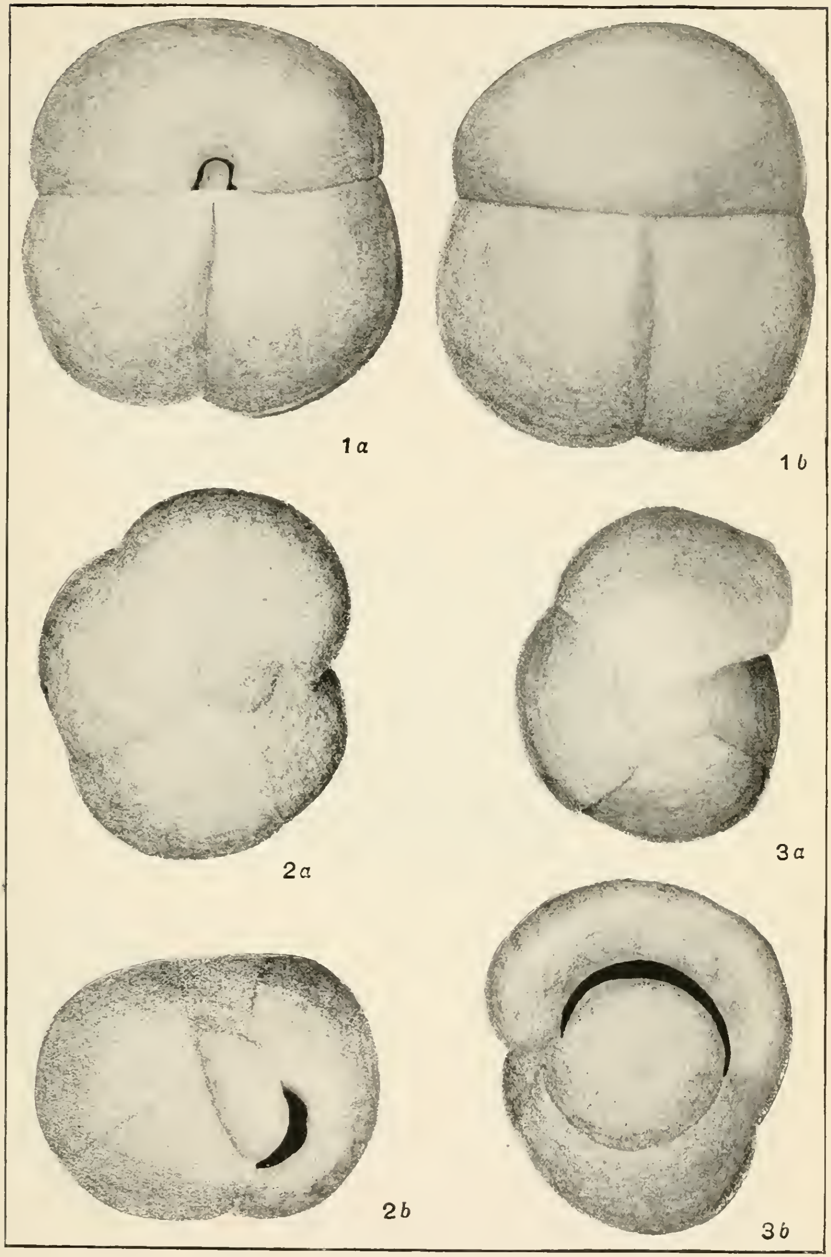
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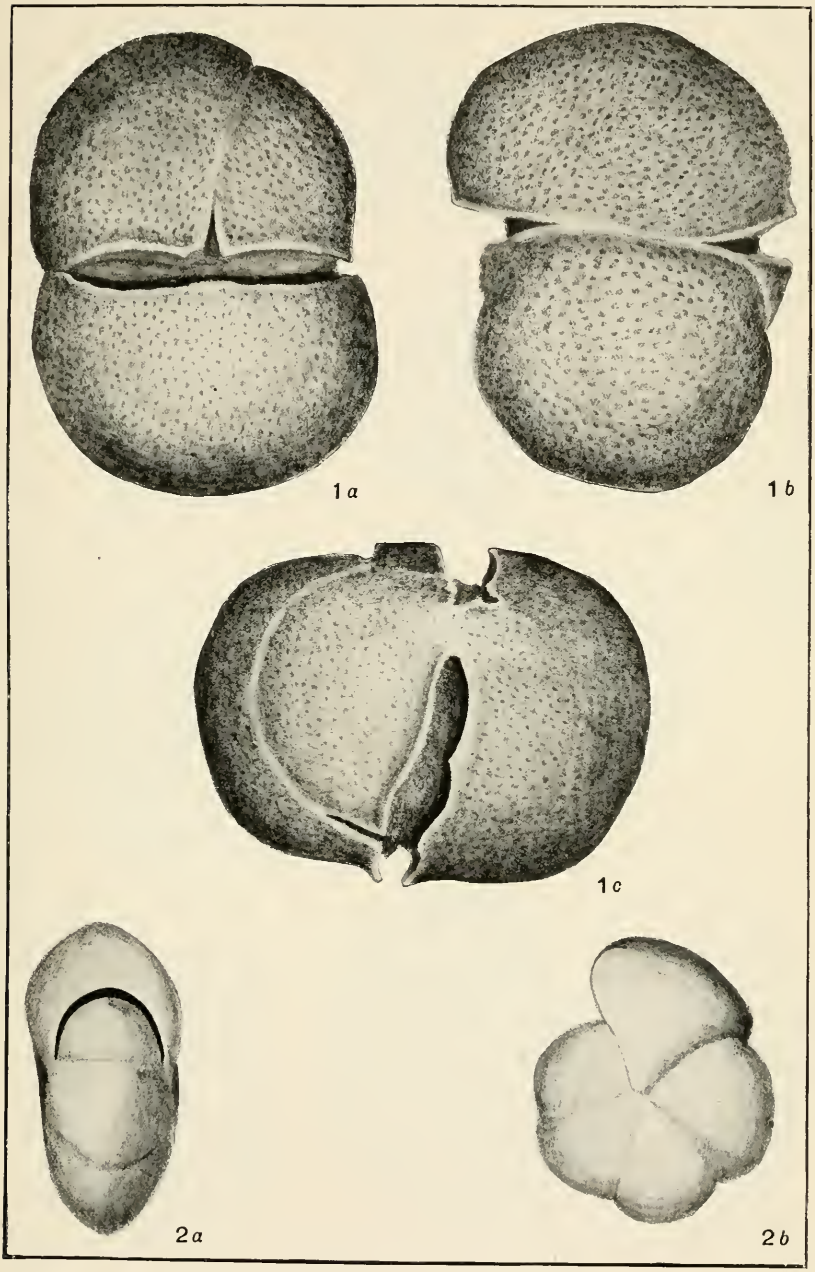

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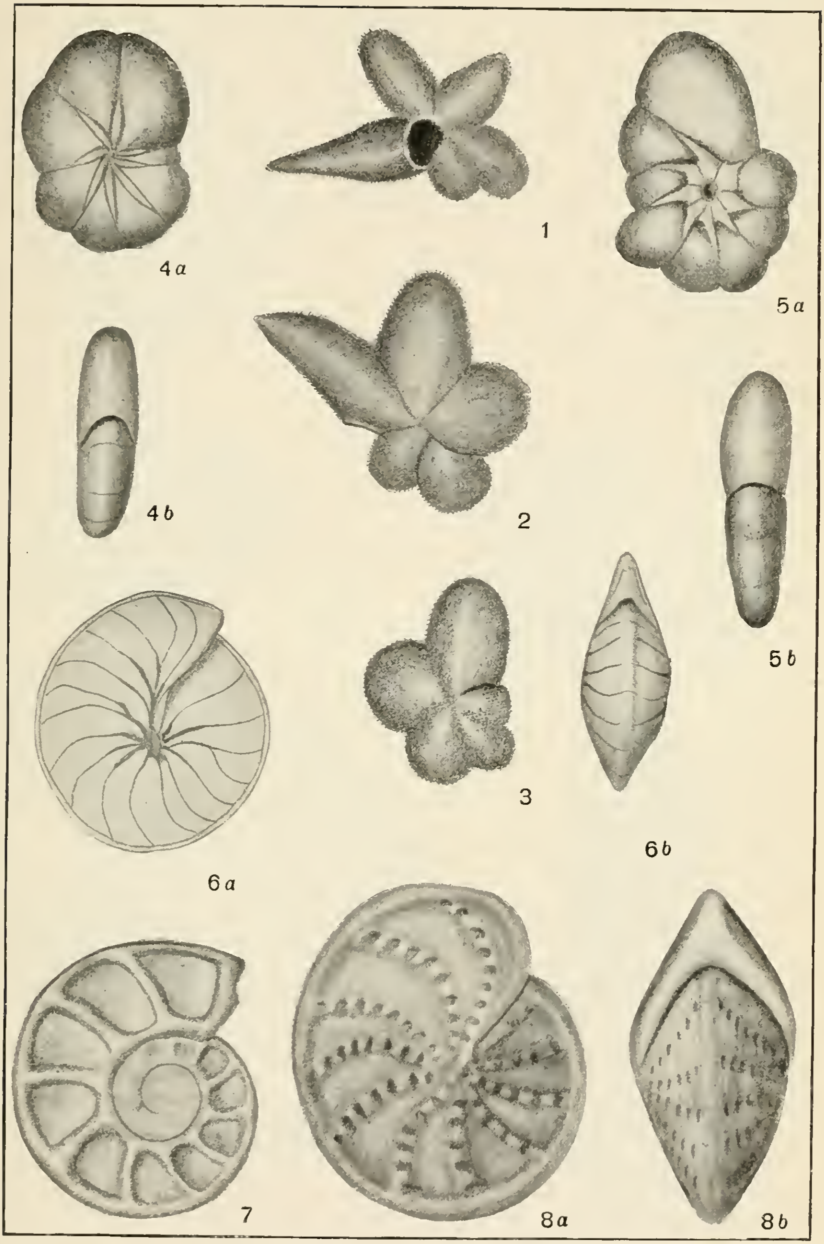
4a
1
5a
4b
2
5b
6a
3
6b
7
8a
8b

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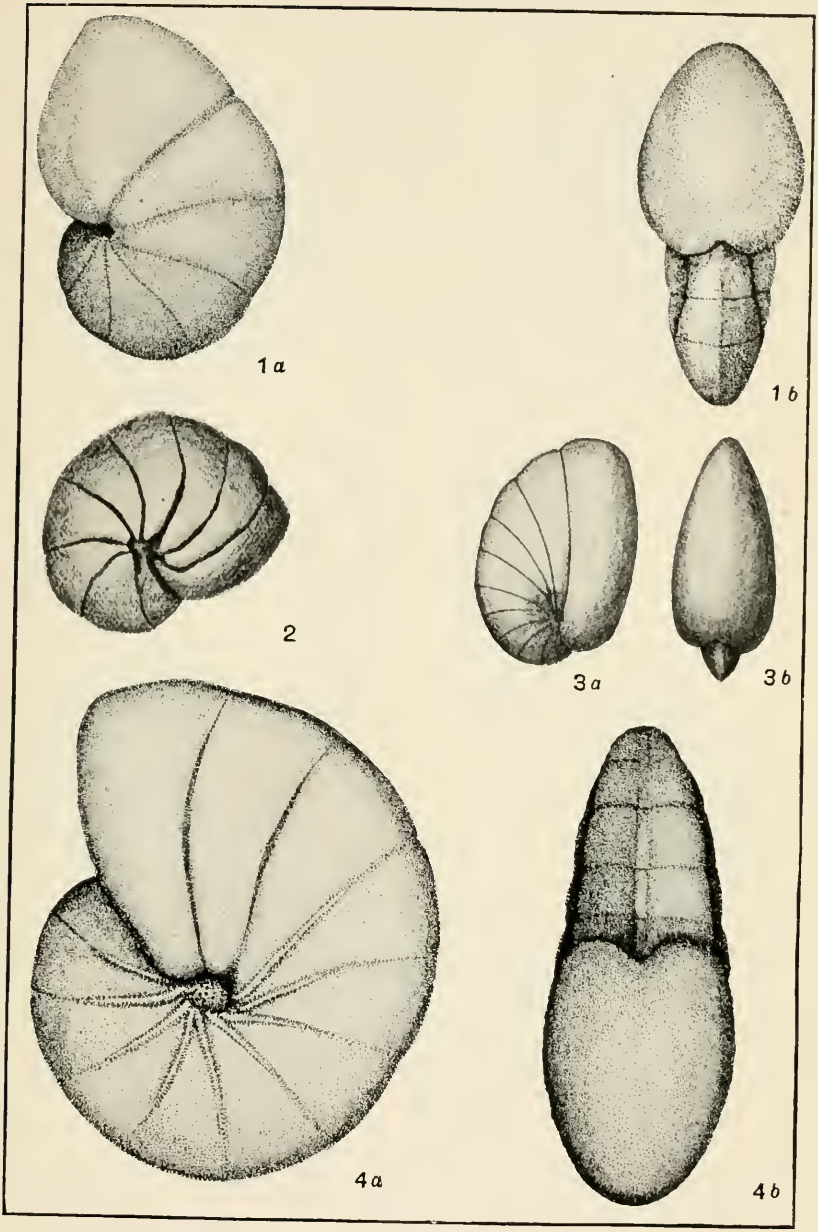
1 a
1 b
2
3 a
3 b
4 a
4 b

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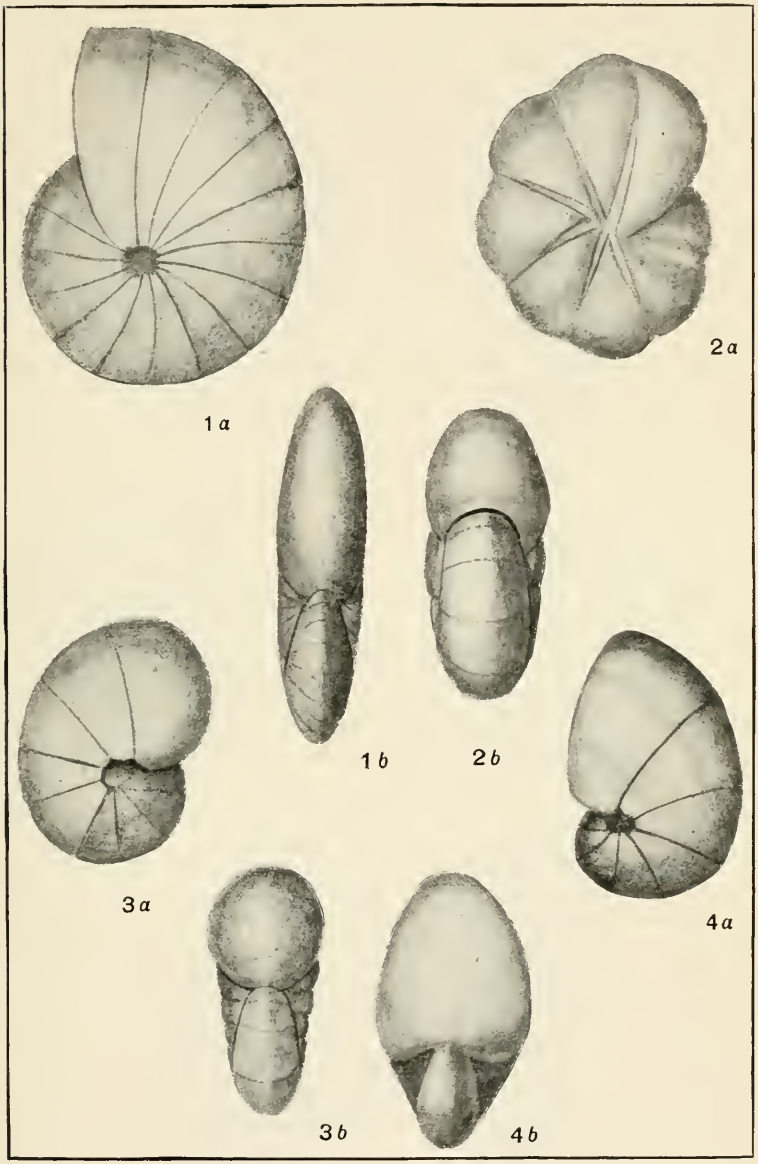
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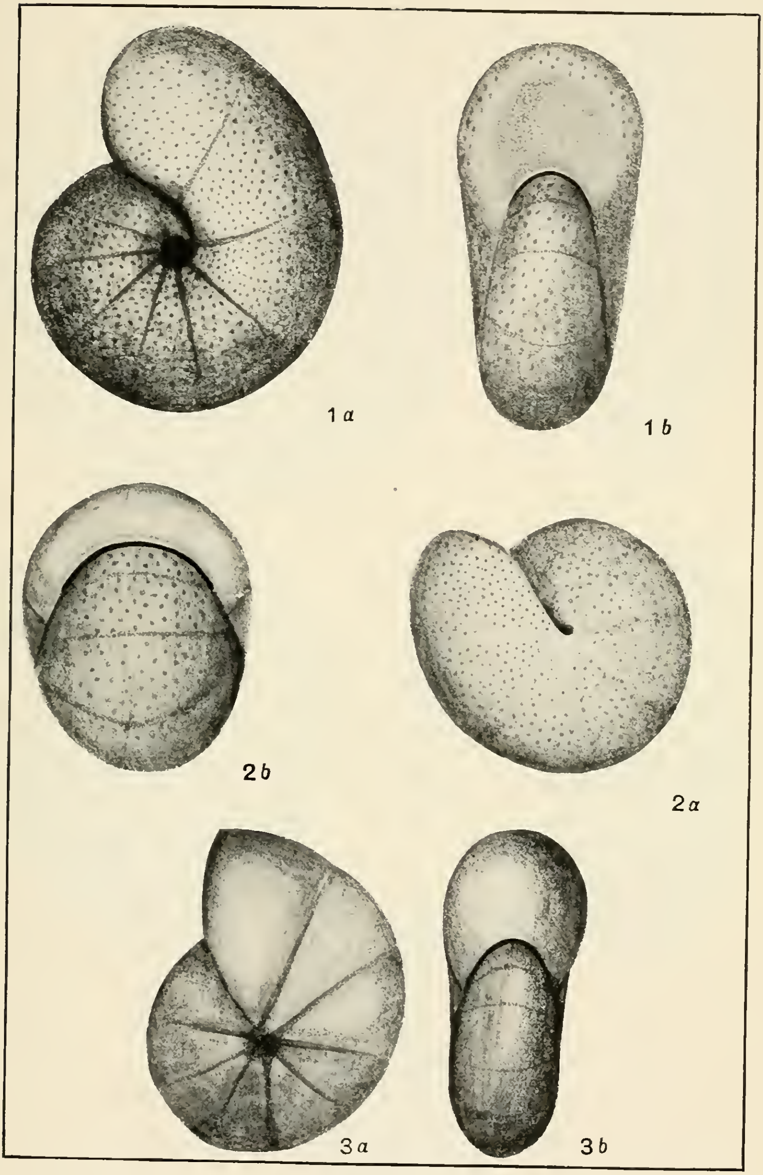
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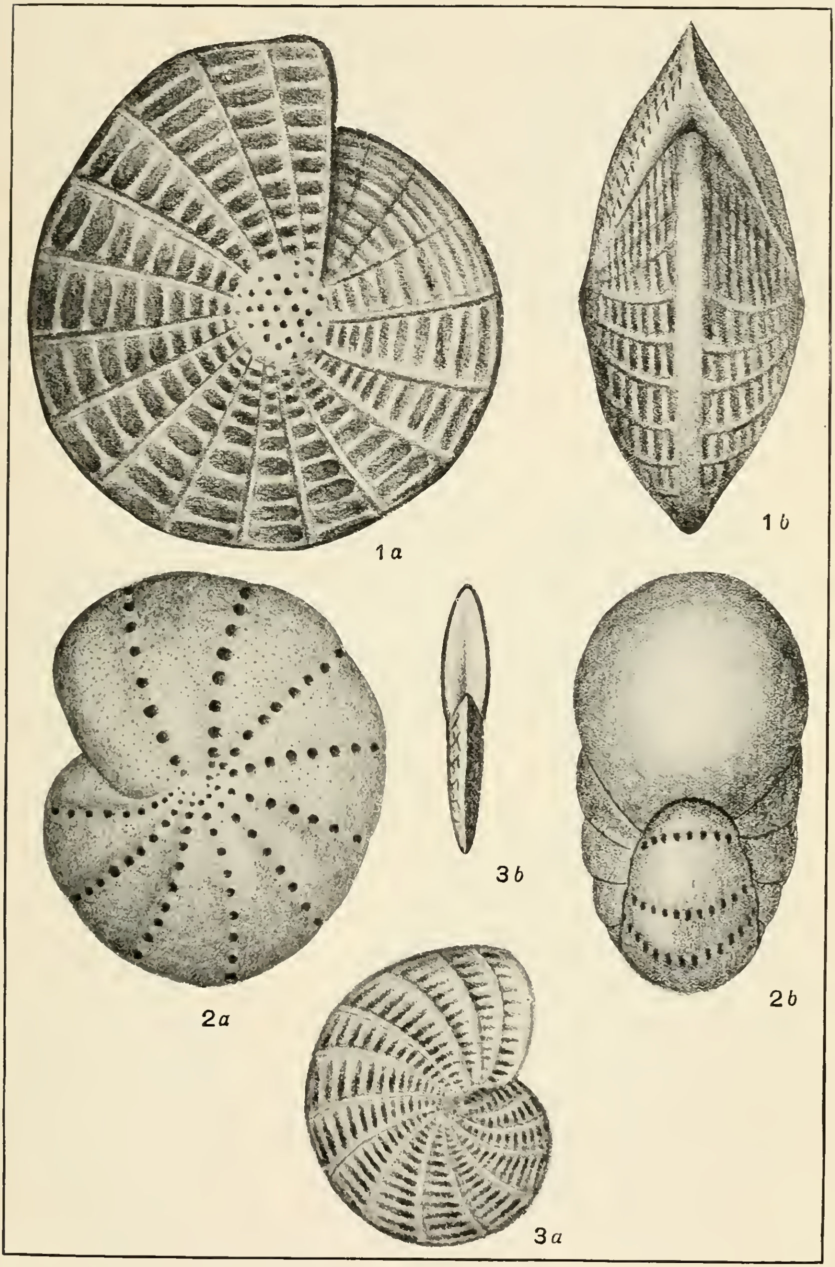
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3 *b*
2 *b*
3 *a*

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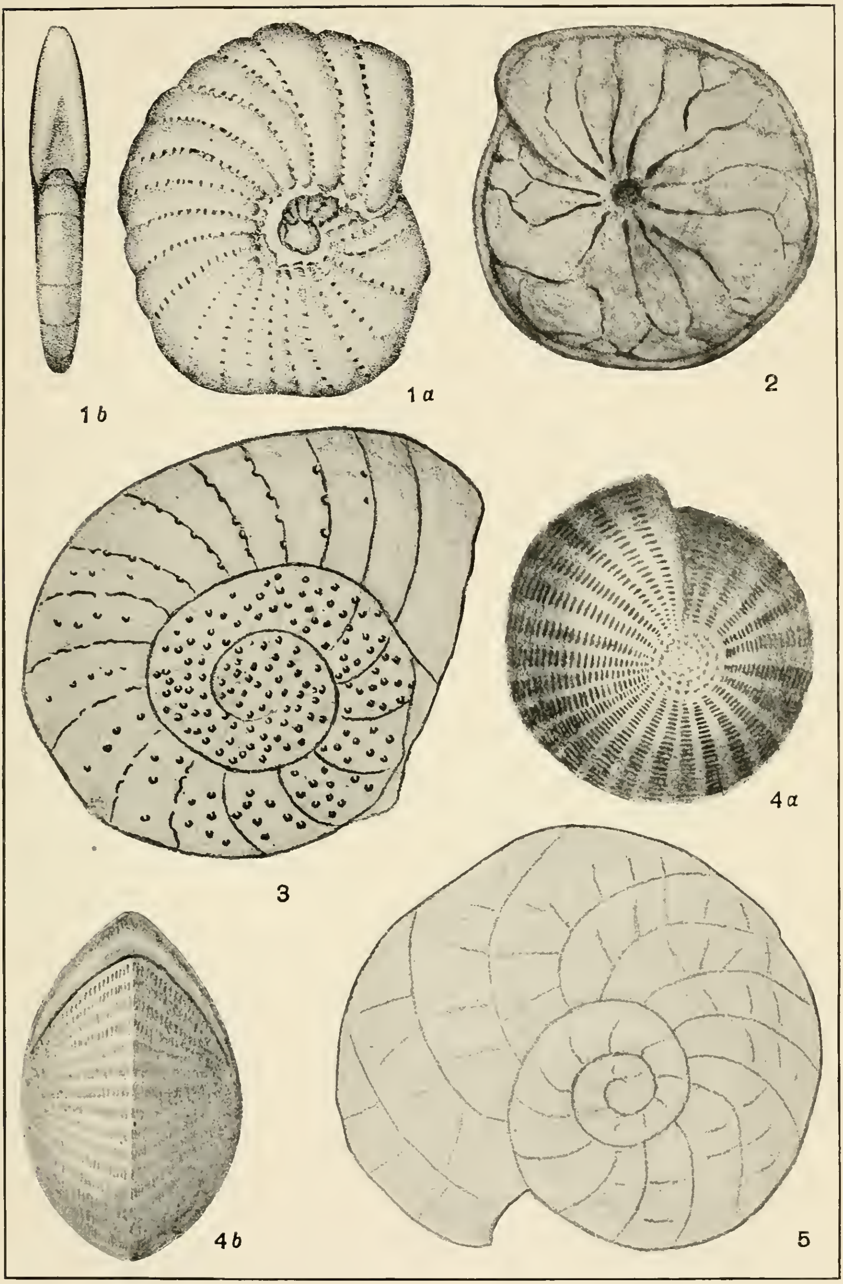
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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
Bulletin 71

A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN

PART V. ROTALIIDÆ

BY

JOSEPH AUGUSTINE CUSHMAN
Of the Boston Society of Natural History

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

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ISSUED APRIL 24, 1915.

INTRODUCTION.

The present volume is the fifth of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the family Rotaliidæ. The first part, issued in 1910, included the families Astrorhizidæ and Lituolidæ; the second part, issued in 1911, the family Textulariidæ; the third part, issued in 1913, the family Lagenidæ; and the fourth part, issued in 1914, included the families Chilostomellidæ, Globigerinidæ, and Nummulitidæ. Part six, the last, will be devoted to the Miliolidæ.

JOSEPH AUGUSTINE CUSHMAN.

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

ROTALIIDÆ.

By Joseph Augustine Cushman,
Of the Boston Society of Natural History.

INTRODUCTION.

This fifth part of the work on the North Pacific Foraminifera deals with the single family Rotaliidæ. In its natural order this family comes before the Nummulitidæ which was the last family treated in the fourth part but which was taken up there in order to better balance the parts, as previously explained.

The members of this family have been widely known and well worked and the new species are not very numerous. However, in some genera the species seem to be more or less localized and often prove to be new. Such genera as *Spirillina* and *Discorbis* are very apt to have new species wherever found.

If the collections which were available for the present paper had included a greater amount of material from shallow water of the tropical portion of the North Pacific, there would undoubtedly have been a larger number of new forms and a greater number of species, as certain genera are especially abundant under such conditions.

It is interesting to note again the occurrence of a considerable number of really tropical species up to the southern coast of Japan, as has been mentioned in previous parts.

In order to have for comparison original figures of many of the species where later authors have included widely differing forms, a series of outline figures has been introduced in the text adapted from the type figure of the species whenever practicable, otherwise from typical figures of subsequent authors.

SYSTEMATIC TREATMENT.

A systematic presentation of the family follows, the arrangement of the data being the same as in preceding parts of this monograph.

Family 8. ROTALIIDÆ.

Test calcareous, perforate, composed usually of numerous chambers, except in the subfamily Spirillininæ, early chambers coiled, and later chambers in typical genera spirally coiled so that the chambers are all visible from the dorsal side and only those of the last formed coil from the ventral side, convexity of the two sides varying greatly; later development in specialized genera being columnar or even arborescent.

This family is one with a great variety of form and a wealth of ornamentation especially in tropical species. Some of the genera, such as *Pulvinulina,* make up a considerable percentage of *Globigerina* ooze and as such are very numerous and widely distributed. Others, such as *Tinoporus* often make up a considerable mass of the foraminiferal content of certain tropical shore sands, as in the Philippines and elsewhere.

There is a regular gradational development, although broken here and there from the simple coiled, nonseptate *Spirillina* to *Rotalia,* where there is a tendency to complex form in supplemental skeleton and internal tubular system reminding one of the Nummulitidæ.

Subfamily 1. SPIRILLININÆ.

Test free or attached, composed of a proloculum and a long coiled tubular second chamber; variously ornamented; aperture at the end of the tube; wall calcareous, perforate.

This subfamily with the single genus *Spirillina* is an excellent parallelism in the Rotaliidæ with the genus *Ammodiscus* in the Lituolidæ and *Cornuspira* in the Miliolidæ. There is a considerable range of form and ornamentation, and most of the species are characteristic of comparatively shallow water especially in the Tropics.

Genus SPIRILLINA Ehrenberg, 1841.

Spirillina EHRENBERG (type, *Spirillina vivipara* Ehrenberg), Abh. Akad. Wiss. Berlin, 1841, p. 422.—H. B. BRADY, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 629.

Operculina REUSS (part), Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 370 (not *Operculina* d'Orbigny, 1826).

Cornuspira SCHULTZE (part), Organ. Polythal., 1854, p. 41.

Description.—Test typically free, occasionally attached, spiral, composed of a subcircular or ovoid proloculum and a long undivided tubular second chamber, coiled regularly in one plane; wall hyaline and perforate; surface smooth or variously ornamented; aperture formed by the open end of the tube.

The genus *Spirillina* is composed of few species, most of which are minute. They are found usually in comparatively shallow water and seemingly most often on muddy bottoms. Some species seem to prefer the mud of coral reefs.

In its general simple structure this genus is analogous to *Cornuspira* among the imperforate calcareous forms and to *Ammodiscus* among the arenaceous forms. By some authors these have been classed together but it seems merely a case of parallelism as is found among so many of the various groups of the Foraminifera.

SPIRILLINA VIVIPARA Ehrenberg.

Plate 1, figs. 1, 2.

Spirillina vivipara Ehrenberg, Abh. Akad. Wiss. Berlin, 1841, p. 442, pl. 3, fig. 41.—Williamson, Mem. and Proc. Manchester Lit. and Philos. Soc., ser. 2, vol. 8, 1848, p. 45, pl., fig. 34.—Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 284, pl. 11, fig. 46; Philos. Trans., vol. 155, 1865, p. 397, pl. 15, fig. 28.—Moebius, Beitr. Meeresfauna Insel Mauritius, 1880, p. 88, pl. 8, figs. 1, 2.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 108, pl. 7, fig. 272.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 630, pl. 85, figs. 1–5.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.) 1885, p. 348, pl. 12, fig. 32.—Bütschli, Morph. Jahrb., vol. 11, 1886, p. 84, pl. 6, fig. 12.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 394, pl. 18, figs. 56–58; vol. 21, 1899, p. 18, pl. 1, figs. 50, 51.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 326, pl. 71, fig. 4.—Millett, Journ. Roy. Micr. Soc., 1903, p. 693.—Rhumbler, Zool. Jahrb., Abth. Syst., vol. 24, 1906, p. 32, pl. 2, fig. 7.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 133.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 6, pl. 1, figs. 12–14; pl. 2, figs. 1–3; vol. 54, No. 16, 1910, p. 24.

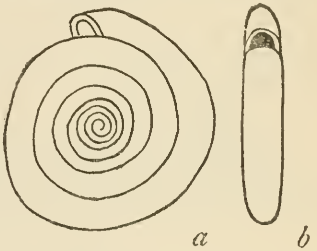


Fig. 1.—Spirillina vivipara Ehrenberg. × 100. *a*, front view; *b*, apertural view. (Adapted from Brady.)

Operculina punctata Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 370, pl. 46, fig. 21.

Cornuspira perforata Schultze, Organ. Polythal., 1854, p. 41, pl. 2, fig. 22.

Spirillina perforata Williamson, Rec. Foram. Great Britain, 1858, p. 92, pl. 7, fig. 202.

Description.—Test typically free, rarely adherent, planospiral, coils of early portion in microspheric specimens at least narrow, those of later coils much wider and of nearly uniform width, faces sometimes flattened but more often concave on both sides; sutures usually distinct and often considerably depressed; peripheral border rounded; wall marked by conspicuous perforations, irregularly scattered and most prominent on the last formed volutions; aperture somewhat crescentic.

Diameter 0.4–0.75 mm.

Distribution.—Brady records the occurrence of this species in the North Pacific without definite station. Rhumbler records it both from Laysan and the Chatham Islands. I have found the species but a few times in the material at my disposal, largely due, I suppose, to the fact that it was with few exceptions from fairly deep water. A single specimen occurred at each of two *Albatross* stations D4309 and D4310, and it also occurred off Guam, *Nero* station 1466.

SPIRILLINA VIVIPARA Ehrenberg, var. REVERTENS Rhumbler.

Plate 1, figs. 3–6.

Spirillina vivipara H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 85, fig. 5 (not figs. 1–4).

Spirillina vivipara, var. *revertens* Rhumbler, Zool. Jahrb. Abth. Syst., vol. 24, 1906, p. 32, pl. 2, figs. 8–10.

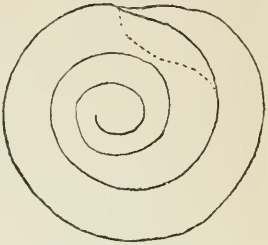


Fig. 2.—Spirillina vivipara, var. revertens Rhumbler. × 250. (After type figure of Rhumbler.)

Description.—Test differing from typical *S. vivipara* in the coiling of the test which is regular in the early ones, then the growing end of the test turns under the disk and grows inward so that finally it approaches the middle of the under side.

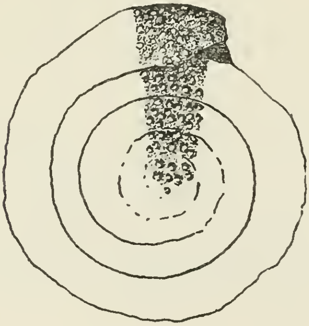
Diameter 0.07 to 0.15 mm.

Distribution.—This variety was found by Rhumbler in material both from Laysan and Chatham Islands. I have had no material referable to this variety.

SPIRILLINA TUBERCULATA H. B. Brady.

Plate 1, figs. 7–9; plate 2, fig. 3.

Spirillina tuberculata H. B. Brady, in Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 50; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 279, pl. 8, fig. 28*a*, *b*; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 631, pl. 85, figs. 12–16.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 395, pl. 18, figs. 62, 63.



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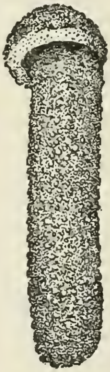

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Figs. 3, 4.—Spirillina tuberculata H. B. Brady. 3, front view, × 45; 4, apertural view, × 50. (Figures from type figures given by Brady.)

Description.—Test free, planospiral, usually slightly asymmetrically coiled, flattened or slightly concave on the dorsal face, slightly excavated at the umbilicus in microspheric specimens; peripheral border usually rounded; wall covered with a secondary deposit of calcareous material obscuring the sutural depressions of all but the final coil, ornamented over the whole exterior with numerous raised tubercles usually more prominent on the dorsal face; aperture somewhat crescentic.

Diameter 0.5 to 1 mm.

Distribution.—Brady gives the only North Pacific record for this species. It was obtained by the *Challenger* off the coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms. Bagg does not record it from this region, but his material, as was that which I have had, came from deeper water. Apparently from Brady's figures of this species he had both microspheric and megalospheric forms of the species.

SPIRILLINA LIMBATA H. B. Brady.

Plate 2, figs. 1, 2.

Spirillina limbata H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 278, pl. 8, fig. 26*a*, *b*; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 632, pl. 85, figs. 18–21.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 395, pl. 18, figs. 43, 44.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 326, pl. 71, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1903, p. 694.

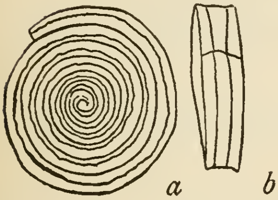


Fig. 5.—Spirillina limbata H. B. Brady. × 60. *a*, front view; *b*, apertural view. (Adapted from Brady.)

Description.—Test planospiral, concave on both sides or merely flattened, composed of numerous regular coils; peripheral border square; wall smooth, the sutural line marked by a raised ridge of calcareous material, perforations small and inconspicuous; aperture somewhat compressed.

Diameter 0.42–0.85 mm.

Distribution.—In the *Challenger* report Brady records this species as occurring at one *Challenger* station in the North Pacific, but does not give depth or location.

SPIRILLINA LIMBATA H. B. Brady, var. DENTICULATA H. B. Brady.

Plate 3, figs. 1, 2.

Spirillina limbata H. B. Brady, var. *denticulata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 632, pl. 85, fig. 17.

Description.—Test very similar in general to that of typical *S. limbata*, but differing in the denticulate character given to the carina of the margin of the chamber by the buttress-like teeth which border it along the inner side.

Distribution.—This variety was described from the East Indian region by Brady, but has not previously been recorded from the North Pacific. I have had it from stations which have shown by their fauna that they are to be considered as belonging to the East Indian fauna to a large extent. They are Gaspar Straits, North Pacific Exploring Expedition, Capt. Rodgers; *Nero* station 1466 off Guam, *Tuscarora* station, 27° 16′ N.; 141° 56′ E., in 108 fathoms, and *Albatross* H4882 at the station in Colnett or Vincennes Strait, where so many southern species were found.

SPIRILLINA LIMBATA H. B. Brady, var. PAPILLOSA, new variety.

Plate 2, fig. 4.

Description.—Test small, composed of a few coils, dorsal side with the borders of the coil decidedly carinate, and more or less regularly wavy, center depressed; periphery sharply angled at the dorsal margin, rounded at the ventral margin, obliquely sloping to the ventral margin which is of smaller diameter than the dorsal; ventral surface strongly papillose, apertural end of the coil cut back so that the periphery is considerably extended.

Diameter about 0.3 mm.

Distribution.—Type-specimen from *Nero* station 2039 in 24 fathoms, near the Hawaiian Islands. (Cat. No. 9023, U.S.N.M.)

This variety differs from the typical in the fewer chambers, more prominent and wavy carina, and the papillose ventral surface which in the typical form is smooth.

Specimens of this variety were later obtained from *Nero* station 1466 in 234 fathoms off Guam, and from *Tuscarora* station 2, lat. 27° 16′ N.; long. 141° 56′ E., in 108 fathoms.

SPIRILLINA INÆQUALIS H. B. Brady.

Plate 3, fig. 3.

Spirillina inæqualis H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 278, pl. 8, fig. 25*a*, *b;* Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 631, pl. 85, figs. 8–11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 394, pl. 18, figs. 40–42.—Millett, Journ. Roy. Micr. Soc., 1903, p. 693.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 34, pl. 2, fig. 12.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 282.

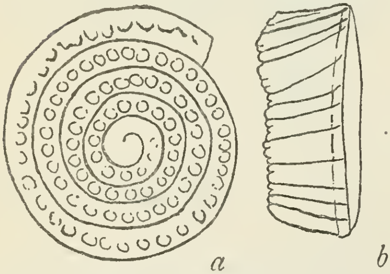


Fig. 6.—Spirillina inaequalis H. B. Brady. × 120. *a*, front view; *b*, side view. (Adapted from Brady.)

Description.—"Test free or adherent, discoidal, relatively thick; consisting of four or five convolutions; inferior (adherent) surface flat, broader than the superior; superior face concave, or excavated at the umbilicus; periphery oblique, margin acute or subcarinate. Shell-wall coarsely perforated; surface uneven, often decked with slightly raised bosses or tubercles.

"Diameter 1/80th inch (0.3 mm.)."

Distribution.—One of the stations from which this species was described by Brady is off the coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms, obtained by the *Challenger*. The only other records for the species in this area are those given by Rhumbler, who found a single specimen from Laysan Island and one from Chatham Island.

The description is from Brady.

SPIRILLINA DECORATA H. B. Brady.

Plate 5, figs. 1, 2.

Spirillina decorata H. B. Brady, Rep. Voy. *Challenger* Zoology, vol. 9, 1884, p. 633, pl. 85, figs. 22-25.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 394, pl. 18, figs. 64, 65.—Millett, Journ. Roy. Micr. Soc., 1903, p. 695.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 33, pl. 2, fig. 11.

Description.—"Test free, discoidal, bilaterally symmetrical or nearly so; composed of six or eight convolutions of a somewhat embracing tube. Lateral faces slightly concave, peripheral edge thin and subcarinate; perforations obscure in thick-walled specimens, the surfaces of which become pitted and furrowed; aperture of the adult somewhat contracted and triangular.

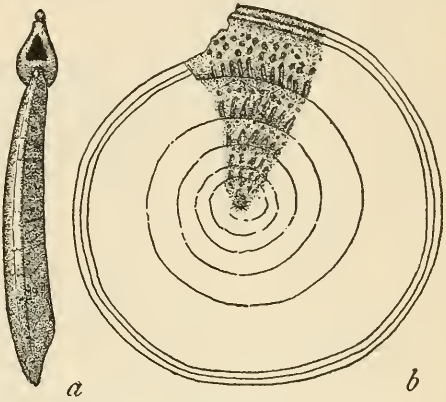


Fig. 7.—Spirillina decorata H. B. Brady. × 50. *a*, side view; *b*, front view. (Adapted from Brady's figure of the type.)

"Diameter 130th inch (0.84 mm.) or more."

Distribution.—Rhumbler records and figures a single specimen of this species from Laysan Island. This is the only record for the North Pacific.

The description is from Brady.

SPIRILLINA OPERCULOIDES, new species.

Plate 4, fig. 2.

Description.—Test small, composed of numerous coils, slightly umbonate on the dorsal surface; surface of dorsal side smooth except the outer coil which is longitudinally striate; periphery rather sharply rounded; ventral side slightly concave; the pores of the wall giving the surface a pitted appearance, otherwise smooth.

Diameter 0.3 mm.

Distribution.—Type-specimen from Nero station 2038 in 34 fathoms, near the Hawaiian Islands (Cat. No. 9024, U.S.N.M.).

This species in its general form is somewhat similar to *S. obconica* H. B. Brady, but is much less excavated below, its surface ornamentation at once distinguishing it from that species.

SPIRILLINA GUTTATA, new species.

Plate 4, fig. 1.

Description.—Test spiral, circular in dorsal view, flattened above, very slightly concave below; wall smooth except for the suture and the slight ornamentation consisting of a single row of slight depressions near the inner border of the chamber; suture decidedly depressed, on the under side the central portion filled with a mass of irregular shell material showing the coils indistinctly and having a somewhat radiating appearance.

Diameter about 1 mm.

Distribution.—Type-specimen (Cat. No. 9025, U.S.N.M.) from *Albatross* station H4881, off Japan in 316 fathoms.

In much tropical material there are found specimens which seem referable to this genus. Especially when the growing edge is broken and appears as a well defined opening the specimens seem at first sight to belong to *Spirillina*. One such specimen is here figured, plate 4, figure 3. After the specimen was figured others came to hand which were more nearly perfect and which seemed to show convincingly that it was a Gastropod operculum of some sort instead of a *Spirillina*.

Subfamily 2. ROTALINÆ.

Test spiral, rotaliform, rarely evolute, very rarely irregular or acervuline; chambers numerous, distinct or in some few species largely obscured by shell growth, early chambers in all distinctly rotaliform.

This subfamily shows a very great range of characters, such genera as *Discorbis* and *Polytrema*, for example, seeming entirely unrelated until the early chambers of each are compared.

Genus PATELLINA Williamson, 1858.

Patellina Williamson (type, *P. corrugata* Williamson) Recent British Foraminifera, 1858, p. 46.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 633.

Description.—Test conical in form or plano-convex; the early chambers spirally arranged, later ones long and becoming annular or nearly so about the periphery; chambers of living forms usually simple but often partially divided by internal septæ, visible from the exterior; aperture elongate, at the inner border of the chamber.

This genus, represented among the fossils by large, striking and often complicated tests, is, in recent species, represented by small, rather simply constructed tests. In the fossil forms there is usually a central core of deposited material about which are the chambers themselves.

This is evidently a genus which is surviving only by its simplest species, the more complex forms having become extinct in past geological periods.

PATELLINA CORRUGATA Williamson.

Plate 7, fig. 1.

Patellina corrugata Williamson, Rec. Foram. Great Britain, 1858, p. 46, pl. 3, figs. 86–89.—Carpenter, Parker, and Jones, Introd. Foram., 1862, p. 229, pl. 13, figs. 16, 17, text-figs. 37, 38.—Parker and Jones, Philos. Trans., vol. 155, 1865, p. 398, pl. 15, figs. 29*a–c*.—Schwager, Boll. Com. geol. Ital., vol. 8, 1887, p. 26, pl., fig. 58.—Bütschli, in Bronn, Klassen und Ordnungen Thier-Reichs, 1880, p. 208, pl. 9, fig. 9.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 634, pl. 86, figs. 1–7.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 393, pl. 15, figs. 70–72.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 92.—Schaudinn, Sitz. Ges. Nat. Freunde zu Berlin, No. 19, 1895, p. 181, text-fig.—Schlumberger, Feuille Jeunes Nat., ser. 3, ann. 26, 1896, p. 129, text-fig.—Wright, Geol. Mag., ser. 4, vol. 7, 1900, p. 100, pl. 5, fig. 20.—Millett, Journ. Roy. Micr. Soc., 1903, p. 696.—Rhumbler, Zool. Jahrb., Abth. Syst., vol. 24, 1906, p. 35.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 134, pl. 10, fig. 7.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 9.—Cushman, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 29, pl. 5, fig. 3.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 419.

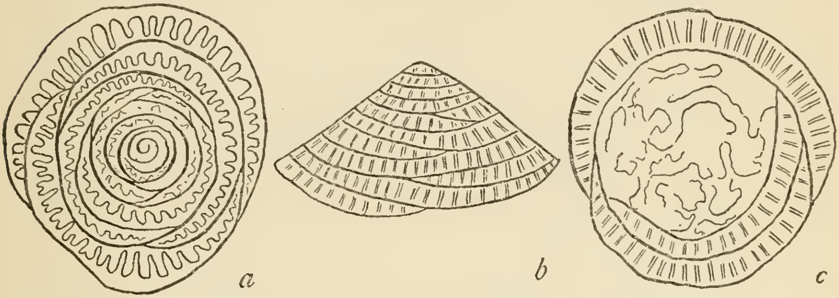


Fig. 8.—Patellina corrugata Williamson. (Adapted from Williamson's original figures.) *a*, dorsal view; *b*, side view; *c*, ventral view.

Description.—Test usually free, conical, or plano-convex; early portion composed of chambers spirally arranged, later ones elongating and finally becoming annular or nearly so in the last-formed portion of the test; chambers partially divided by internal septæ which are visible from the exterior, showing clearly in the last-formed chambers from the ventral side; somewhat umbilicate ventrally; walls comparatively thin and translucent; aperture somewhat elongate situated at the inner border of the chamber.

Diameter 0.138–0.636.

Distribution.—The only North Pacific records for this species are given by Rhumbler who found it in material from Laysan and from Chatham Island, one specimen from each locality.

Genus DISCORBIS Lamarck, 1804.

Discorbis Lamarck (type, *D. vesicularis* Lamarck), Ann. Mus., vol. 5, 1804, p. 183.

Discorbites Lamarck, Ann. Mus., vol. 5, 1804, p. 183.

Discorbina Carpenter, Parker and Jones, Introd. Foram., 1862, p. 203.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 641.

Description.—Test free or attached, spiral and rotaliform, plano-convex or biconvex, or modified variously in different species; typically plano-convex with the ventral side flattened and the dorsal convex; all chambers visible from the dorsal side, only those of the last-formed coil visible from the ventral side; test composed of several coils, usually three or four in the adult test; chambers rather numerous; aperture a slit at the umbilical margin of the ventral side of the chamber.

The various species of this genus show a considerable range of characters, some of them such as *D. tabernacularis* being very different from the typical form. As a rule they seem to be most common in comparatively shallow water, and for this reason undoubtedly the number which I have had is comparatively small as most of the *Albatross* and *Nero* material has come from rather deep water.

DISCORBIS TURBO (d'Orbigny).

Plate 11, fig. 2.

Rotalia (Trochulina) turbo d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 274, No. 39; Modèles, No. 73.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 30, pl. 2, fig. 68.—Basset, Ann. Soc. Sci. Charente Inf., 1884 (1885), p. 162, fig.

Rotalia turbo Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 306.

Discorbina turbo Carpenter, Parker, and Jones, Introd. Foram., 1862, p. 200.—Bütschli, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 206, pl. 9, fig. 10.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 193, pl. 3, figs. 35, 36.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 642, pl. 87, figs. 8*a–c*.—Egger, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 389, pl. 15, figs. 42–44.—Chapman, Journ. Roy. Micr. Soc., 1896, p. 591, pl. 13, fig. 13.—Millett, Journ. Roy. Micr. Soc., 1903, p. 697.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 81.

Description.—Test plano-convex; dorsal surface conically rounded, ventral side flat or very slightly convex; peripheral margin rather sharp; chambers numerous, about six or seven in the last-formed whorl, stout; sutures curved backward, slightly if at all depressed above, ventrally somewhat depressed toward the peripheral border, toward the umbilicus broadly limbate, forming a stellate pattern; surface with coarse perforations, on the ventral side the periphery has a bordering carina with radial markings; aperture a narrow slit at the base of the chamber partially covered with a valvular projection.

Diameter 0.50–0.85 mm.

Distribution.—Bagg records this species from *Albatross* station H4694 in 865 fathoms, off the Hawaiian Islands, as rare. The only material I have had was from *Albatross* station H4882 off Blake Reef, in Colnett or Vincennes Strait off southern Japan.

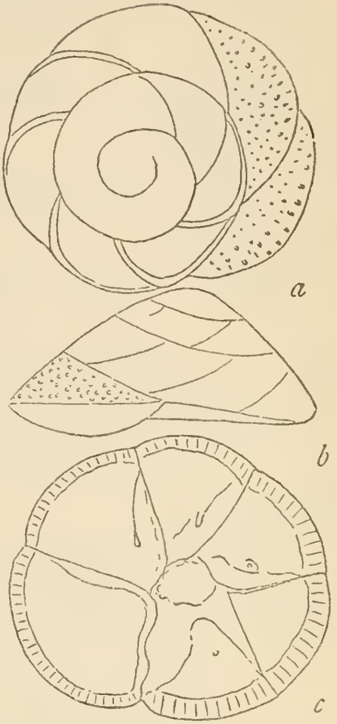


Fig. 9.—Discorbis turbo (d'Orbigny). × 60. *a*, dorsal view; *b*, side view; *c*, ventral view. (Adapted from Brady.)

DISCORBIS GLOBULARIS (d'Orbigny).

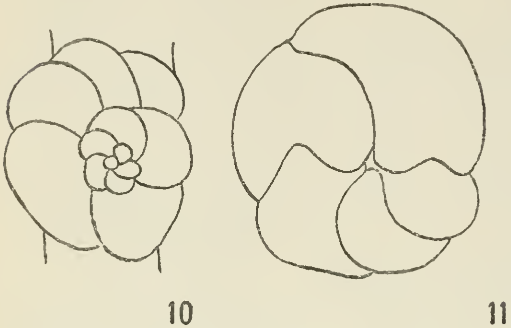
Plate 9, fig. 4.

Rosalina globularis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 271, pl. 13, figs. 1–4; Modèles, No. 69.

Discorbina globularis Carpenter, Parker, and Jones, Intro. Foram., 1862, p. 204, pl. 3, fig. 1.—Dawson, Can. Nat., ser. 2, vol. 7, 1874, p. 253, fig. *c*.—Moebius, Beitr. Meeresfauna Insel Mauritius, 1880, p. 96, pl. 9, fig. 18.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 643, pl. 86, figs. 8, 13.—H. B. Brady, Parker, and Jones, Trans Zool. Soc. London, vol. 12, 1888, p. 226, pl. 46, fig. 6.—Terrigi, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 115, pl. 6, fig. 20.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, pl. 15, figs. 7–9.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 94, pl. 15, fig. 793.—Chapman, Journ. Roy. Micr. Soc., 1896, p. 590, pl. 13, fig. 11.—Morton, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 120, pl. 1, fig. 22.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 327, pl. 72, fig. 2.—Wright, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 21.—Chapman, Geol. Mag., dec. 4, vol. 7, 1900, pl. 14, fig. 8.—Millett, Journ. Roy. Micr. Soc., 1903, p. 698.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 68.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 134.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 11, pl. 3, figs. 3–8, pl. 4, figs. 1, 2; vol. 54, No. 16, 1910, p. 25.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, Oct. 1910, p. 419, pl. 55, figs. 14*a*, *b*.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 81, pl. 24, fig. 15.

Discorbina turbo, var. *vesicularis*, subvar. *globularis* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 386, pl. 14, figs. 22, 23.

Description.—Test plano-convex, the dorsal side convexly rounded the ventral side flattened or slightly concave; peripheral margin rounded, keeled; chambers few in each whorl, usually about five in the last-formed whorl; sutures slightly depressed dorsally and limbate with clear shell material as is also the margin except in the last few chambers, finely perforated and hyaline; ventral side with the sutures much depressed, the chambers smooth, the last-formed chamber occupying nearly half the surface, periphery carinate with radiating lines; aperture fairly large, irregular, elongate, at the inner margin of the chamber.



Figs. 10, 11.—Discorbis globularis (d'Orbigny). (Adapted from d'Orbigny's original figures.) 10. Dorsal view. 11. Ventral view.

Diameter 0.55–0.85 mm.

Distribution.—The only published record for this species is that of Rhumbler, who found it in shallow water material from Laysan Island. I have had the species from *Albatross* station D4875 in 59 fathoms, eastern channel of Korea Strait.

DISCORBIS GLOBULARIS (d'Orbigny), var. BRADYI, new variety.

Plate 8, fig. 1.

Discorbina globularis H. B. Brady (not *D. globularis* d'Orbigny), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 86, fig. 8.

Description.—Chambers of earlier portion of the test on the dorsal side clearly outlined with limbate sutures; ventral side with a peripheral border with a milled edge, the chambers more or less swollen, the proximal portion separated from the rest, and the last-formed chamber with a peculiar bifid indentation extending inward from the peripheral region; color brownish.

Diameter about 0.80 mm.

Distribution.—Type-specimen of variety, from *Albatross* station D4893 in 106 fathoms, bottom temperature 55.9° F. off Japan (U. S. N. M. No. 9027).

This variety seems distinct from the typical *D. globularis* d'Orbigny. The limbations and peculiar conditions of the ventral side seem sufficient to distinguish it.

DISCORBIS OBTUSA (d'Orbigny).

Rosalina obtusa d'Orbigny, For. Foss. Bass. Tert. Vienne, 1846, p. 179, pl. 11, figs. 4–6.

Discorbina obtusa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 644, pl. 91, fig. 9*a–c*.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 156.

Discorbina (*Rosalina*) *obtusa* Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 391, pl. 15, figs. 67–69.

Discorbina turbo, var. *vesicularis*, subvar. *obtusa* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 386, pl. 14, figs. 18, 19.

Description.—Test biconvex, dorsal side slightly more so than the ventral side; peripheral margin rounded; chambers comparatively few, about five in the last-formed whorl; sutures curved, depressed; surface with numerous perforations; aperture an elongate narrow slit extending from the umbilicus nearly to the periphery on the ventral border of the chamber.

Diameter up to 1 mm.

Distribution.—Bagg records this species from *Albatross* station H4568 in 1,274 fathoms off the Hawaiian Islands. This seems to be the only North Pacific record for this species.

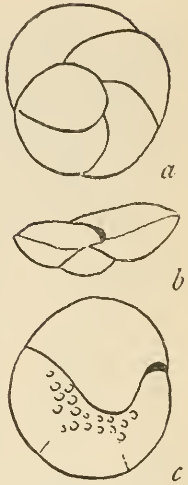


Fig. 12.—Discorbis obtusa (d'Orbigny). (Adapted from d'Orbigny's original figure.) *a*, dorsal view; *b*, side view; *c*, ventral view.

DISCORBIS ROSACEA (d'Orbigny).

Rotalia rosacea d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 273, No. 15; Modèles, No. 39.

Asterigerina rosacea d'Orbigny, Prod. Pal., vol. 3, 1852, p. 158, No. 2952.

Discorbina rosacea H. B. Brady, Trans. Linn. Soc., vol. 24, 1864, p. 473, No. 69.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 25, pl. 2, fig. 71.—Parker, Jones, and H. B. Brady, Pal. Soc. Monograph 19, 1866, pl. 4, fig. 17.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 105, pl. 8, figs. 251–257.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 644, pl. 87, figs. 1, 4.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 385, pl. 15, figs. 39–41.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 94, pl. 15, fig. 792.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 327, pl. 72, fig. 3.—Millet, Journ. Roy. Micr. Soc., 1903, p. 698.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 135.—Cushman, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 30.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 12, pl. 4, figs. 3–5; vol. 54, No. 16, 1910, p. 25.

Discorbina turbo, var. *rosacea* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 385, pl. 16, fig. 28*a*, *b*.

Description.—Test plano-convex, dorsal side conically convex, ventral side flat or somewhat concave; peripheral margin acute, carinate; chambers numerous, six or seven in the last-formed whorl, rather broad; sutures slightly curved, either depressed or limbate with clear shell material as is also the peripheral margin; dorsally rather coarsely perforate, and also ventrally, umbilical region either wide open or closed by a stellate callouslike thickening of clear material; aperture a rather large opening, elongate, often with a valvular umbilical end.

Diameter 0.40–1 mm.

Distribution.—Flint records *D. rosacea* from a single station in the North Pacific, "coast of Alaska, station unknown." I have had a few typical specimens from *Albatross* station D2932 in 20 fathoms.

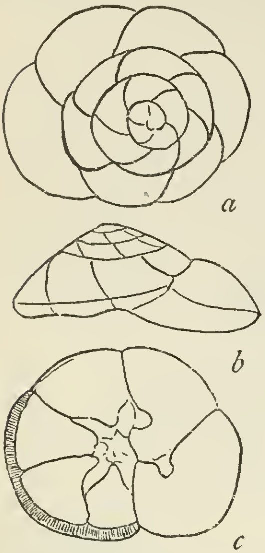


Fig. 13.—Discorbis rosacea (d'Orbigny). × 100. *a*, dorsal view; *b*, side view; *c*, ventral view. (Adapted from Brady.)

DISCORBIS VILARDEBOANA (d'Orbigny).

Plate 9, fig. 2.

Rosalina vilardeboana d'Orbigny, Voy. Amér. Mérid., 1839, "Foraminifères," p. 44, pl. 6, figs. 13–15.

Discorbina vilardeboana Parker and Jones, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 115.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 645, pl. 86, figs. 9, 12; pl. 88, fig. 2.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 387, pl. 15, figs. 13–15.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 95, pl. 16, fig. 796.—Chapman, Journ. Roy. Micr. Soc., 1898, p. 15, pl. 2, fig. 16.—Millett, Journ. Roy. Micr. Soc., 1903, p. 699.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 68.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 12; vol. 54, No. 16, 1910, p. 25.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 82, pl. 28, fig. 9*a–c*.

Description.—Test plano-convex, dorsal side rather evenly rounded, ventral side flattened or slightly concave; peripheral margin rounded; chambers five to seven in the last-formed whorl, the last-formed one, especially on the ventral side, often occupying nearly one-third of the ventral surface; sutures clear, slightly depressed, more so on the ventral side, which is often slightly umbilicate; wall finely punctate; aperture an arched slit running from the umbilicus nearly to the peripheral margin; early chambers often brownish in color.

Diameter 0.40–0.60 mm.

Distribution.—Brady records this species with *D. auracana* from the shores of Japan. Bagg had it from two *Albatross* stations in the vicinity of the Hawaiian Islands, H4440 in 1,259 fathoms and H4568 in 1,274 fathoms. Rhumbler records it from Laysan Island.

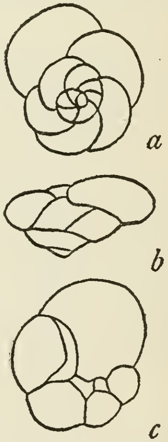


Fig. 14.—Discorbis vilardeboana (d'Orbigny). (Adapted from d'Orbigny's figure of the type.) *a*, dorsal view; *b*, side view; *c*, ventral view.

I have had specimens from material labelled "off Alaska" and from *Albatross* station D4971 in 649 fathoms, bottom temperature 38.1° F. off Japan.

DISCORBIS AURACANA (d'Orbigny).

Plate 9, fig. 3.

Rosalina auracana d'Orbigny, Voy. Amér. Mérid., 1839, "Foraminifères," p. 44, pl. 6, figs. 16–18.

Discorbina auracana Parker and Jones, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 115.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 645, pl. 86, figs. 10, 11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 386, pl. 14, figs. 4–6.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 12; vol. 54, No. 16, 1910, p. 25.

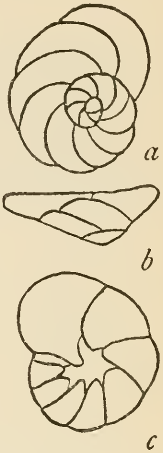


Fig. 15.—Discorbis auracana (d'Orbigny). (Adapted from type figure of d'Orbigny.) *a*, dorsal view; *b*, side view; *c*, ventral view.

Description.—Test small, plano-convex, dorsal side slightly convex, ventral side flat or slightly concave, peripheral margin rather acutely rounded; chambers six to nine in the last-formed whorl, sutures slightly depressed, often limbate with clear shell material, early chambers often carinate with similar material; wall finely punctate; aperture a narrow, curved slit at the margin of the ventral side of the chamber; color brownish, especially the earlier chambers.

Diameter 0.30–0.50 mm.

Distribution.—Apparently the only North Pacific record for this species is that of Brady, who records it from the shores of Japan. I have not found well-characterized specimens.

DISCORBIS ISABELLEANA (d'Orbigny).

Plate 6, fig. 1.

Rosalina isabelleana d'Orbigny, Voy. Amér. Mérid., 1839, "Foraminifères," p. 43, pl. 6, figs. 10–12.

Discorbina isabelleana Parker and Jones, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 115.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 646, pl. 88, figs. 1*a–c*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 386, pl. 15, figs. 36–38.

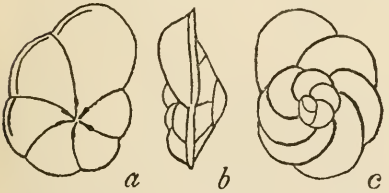


Fig. 16.—Discorbis isabelleana (d'Orbigny). *a*, ventral view; *b*, side view; *c*, dorsal view. (After d'Orbigny's type figure.)

Description.—Test biconvex, smooth, five to six chambers in a coil, limbate dorsally, ventrally the sutures depressed; umbilical region filled and umbonate; peripheral margin acute; aperture a narrow slit extending backward from the margin toward the umbilical region.

Diameter 0.25–0.40 mm.

Distribution.—The only station from which I have had this species is *Nero* 991 in 1,143 fathoms off Guam.

DISCORBIS CONCINNA (H. B. Brady).

Plate 5, fig. 3.

Discorbina concinna H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 646, pl. 90, figs. 7, 8.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 388, pl. 15, figs. 22-24.—Millett, Journ. Roy. Micr. Soc., 1903, p. 699.

Description.—Test free, outline circular, superior face convex, inferior somewhat concave, peripheral edge angular, composed of somewhat more than two convolutions, of which the latest consists of from three to four segments. Earlier segments in their superior aspect short and radial, later segments long and crescentiform; on the inferior side the final segment occupying nearly half the entire surface, umbilical flaps distinct but not greatly developed. Walls very thin and conspicuously perforated, sutures marked by fine lines, neither depressed nor limbate externally.

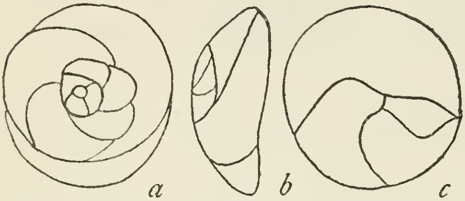


Fig. 17.—Discorbis concinna (H. B. Brady). × 100. *a*, dorsal view; *b*, side view; *c*, ventral view. (After Brady's figure of the type.)

Diameter 1/100th inch (0.25 mm.).

Distribution.—The only North Pacific record for this species is that given by Brady in the *Challenger* report, off the Philippines, in 95 fathoms. From the other records given by Brady it seems as though this species should be found in shallow water off southern Japan, but it was not noted in the small amount of material available from this region in the present work. The figure and description are from Brady.

DISCORBIS ORBICULARIS (Terquem).

Plate 11, fig. 1.

Rosalina orbicularis Terquem, Anim. sur la Plage de Dunkerque, 1876, p. 75, pl. 9, figs. 4*a*, *b*.

Discorbis orbicularis Berthelin, Foram. de Borgneuf et Pornichet, 1878, p. 39, No. 63.

Discorbina orbicularis H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 647, pl. 88, figs. 4-8.—Balkwill and Millett, Journ. Micr., vol. 3, 1884, p. 23, pl. 4, fig. 13.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 349, pl. 13, figs. 31-33.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 46, fig. 1.—Terrigi, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 115, pl. 17, figs. 2, 3.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 389, pl. 15, figs. 16-18, 76-78.—Jones, Pal. Soc., 1895, p. 295, pl. 7, fig. 31.—Millett, Journ. Roy. Micr. Soc., 1903, p. 699.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 13, pl. 4, fig. 7.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 282.

Description.—Test dorsally convex, concave below; chambers two to four in final whorl, elongate; peripheral border acute, keeled sometimes; sutures either marked by fine lines or considerably limbate; ventral side with but three to five chambers visible; wall punctate.

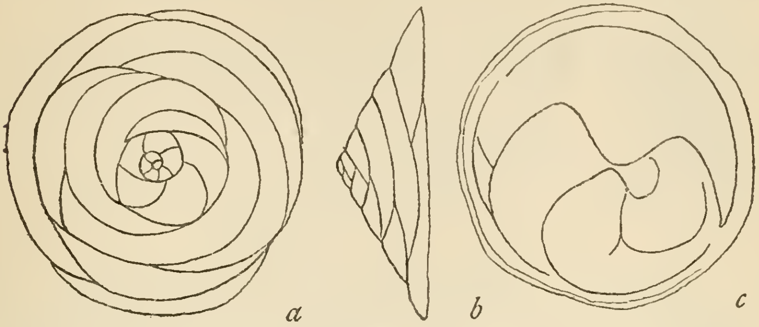


FIG. 18.—DISCORBIS ORBICULARIS (TERQUEM). × 100. *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER BRADY.)

Diameter, 0.50–0.84 mm.

Distribution.—I have had specimens of this species from off Hakodate, Japan, and from *Albatross* station D4875 in 59 fathoms, eastern channel of Korea Strait and from D4949 in 110 fathoms off Japan. This species had apparently not previously been recorded from the North Pacific.

DISCORBIS PATELLIFORMIS (H. B. Brady).

Plate 5, fig. 5.

Discorbina patelliformis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 647, pl. 88, figs. 3*a–c*; pl. 89, figs. 1*a–c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 390, pl. 15, figs. 48–50.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 700.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 68.

Description.—Test free; superior side conical, inferior flat, peripheral edge acute; in the adult state composed of fully three convolutions, of which the outermost has from five to seven segments; segments in their superior aspect long and narrow, the sutures and margin marked by broad lines of clear shell substance, but not limbate externally. Superior surface smooth; inferior ornamented either with faint riblets radiating from

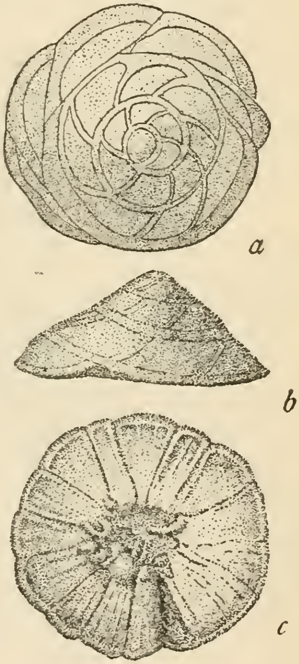


FIG. 19.—DISCORBIS PATELLIFORMIS (H. B. BRADY). × 100. *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER BRADY.)

the umbilicus or with lines of closely set granules, sometimes with larger tubercles near the center.

Diameter about 1/70th inch (0.36 mm.).

Distribution.—This species was described by Brady from shallow water dredgings among the islands of the South Pacific. The only North Pacific record is that given by Rhumbler, who found it in material from shallow water of Laysan Island.

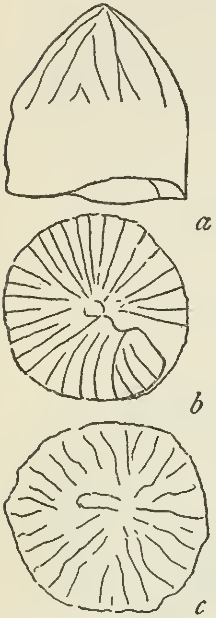


FIG. 20.—DISCORBIS TABERNACULARIS (H. B. BRADY). × 100. *a*, SIDE VIEW; *b*, VENTRAL VIEW; *c*, DORSAL VIEW. (ADAPTED FROM BRADY.)

DISCORBIS TABERNACULARIS (H. B. Brady).

Plate 5, fig. 4.

Discorbina tabernacularis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 65; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 648, pl. 89, figs. 5–7.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 390, pl. 15, figs. 58–60, 79.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 700.—RHUMBLER, Zool. Jahrb, Abt. Syst., vol. 24, 1906, p. 69.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 15; vol. 54, No. 16, 1910, p. 25, pl. 3, fig. 12.

Description.—"Test free; contour that of a tall cone with somewhat convex sides and more or less concave base, often deeply sunken at the umbilicus. Segments long, oblique, arranged in about three convolutions; the septal lines of small or immature specimens limbate externally, those of larger shells concealed by the general thickening of the walls of the test. Inferior surface ornamented with radiating striae or crenulations; superior with striae or irregular costae radiating from the apex.

"Diameter 1/100th inch (0.25 mm.) or less."

Distribution.—This is another species found in the shallow water about tropical islands. Brady records it from the coral reefs off Honolulu, Hawaii, at a depth of 40 fathoms. Rhumbler records it from shallow water material off Laysan Island. I have had no shallow water material which would be apt to contain this species and so have no records for it from this area.

DISCORBIS OPERCULARIS (d'Orbigny).

Plate 11, fig. 3.

Rosalina opercularis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 271, No. 7; in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 101, pl. 3, figs. 24, 25; pl. 4, fig. 1.

Discorbina opercularis Parker and Jones, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 114.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 650, pl. 89, figs. 8, 9.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 389, pl. 15, figs. 73–75.—Millett, Journ. Roy. Micr. Soc., 1903, p. 701.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 69.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 135.

Description.—Test nearly circular, very much compressed, plano-convex, dorsal side slightly conical, ventral side nearly flat; peripheral margin rather sharp; chambers numerous, about seven to nine in the final whorl, very long and narrow, spirally arranged; sutures distinct but slightly if at all depressed; wall on dorsal side often showing rather prominent granulation; borders of the chambers often slightly carinate; ventral side, especially near the center, with very prominent tubercles somewhat radiately arranged and smaller toward the periphery; aperture a very narrow elongate slit at the ventral border of the chamber.

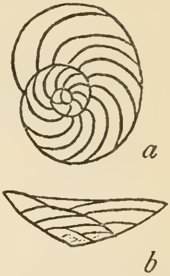


Fig. 21.—Discorbis opercularis (d'Orbigny). × 66. (Adapted from d'Orbigny's original figure.) *a*, dorsal view; *b*, side view.

Diameter 0.40–0.50 mm.

Distribution.—The only published record for this species in the North Pacific is that of Rhumbler, who obtained two specimens in material from Chatham Island. I have had the species only from *Albatross* station D4807 in 44 fathoms off Japan.

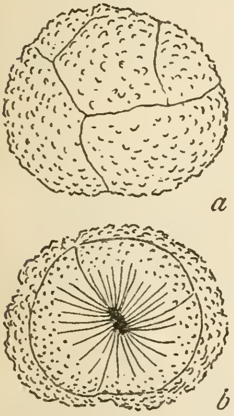


Fig. 22.—Discorbis pulvinata (H. B. Brady). × 100. (After Brady.) *a*, dorsal view; *b*, ventral view.

DISCORBIS PULVINATA (H. B. Brady).

Plate 7, fig. 2.

Discorbina pulvinata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 650, pl. 88, fig. 10*a*, *b*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 391, pl. 15, figs. 33–35.—Millett, Journ. Roy. Micr. Soc., 1903, p. 701.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 70.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 14, pl. 5, fig. 4.

Description.—"Test broadly ovate or subglobular, somewhat depressed; composed of a few more or less inflated segments, about three in the final convolution; superior face rugose externally; inferior deeply excavated at the umbilicus and ornamented with radiating granulose lines.

"Diameter 1/90th inch (0.28 mm.)."

Distribution.—Rhumbler records a single specimen of this species from Laysan. This is the only North Pacific record for the species.

Brady described it from shallow water material of the South Sea Islands.

DISCORBIS BERTHELOTI (d'Orbigny).

Plate 7, fig. 3.

Rosalina bertheloti d'Orbigny, in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, "Foraminiferes," 1839, p. 135, pl. 1, figs. 28–30.

Discorbina bertheloti H. B. Brady, Trans. Linn. Soc. London, vol. 24, 1864, p. 469, pl. 48, figs. 10*a*, *b;* Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 650, pl. 89, figs. 10–12.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 46, figs. 7, 8.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 387, pl. 15, figs. 10–12.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 327, pl. 72, fig. 4.—Millett, Journ. Roy. Micr. Soc., 1903, p. 702.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 70.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 135.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 26.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 80, pl. 28, figs. 10, 11*a*, *b*.

Discorbina berthelotiana MacDonald, Ann. Mag. Nat. Hist., ser. 2, vol. 20, 1857, p. 193, pl. 6, fig. 25.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 107, pl. 8, figs. 266–268; vol. 25, No. 9, 1894, p. 93, pl. 15, fig. 790; Bull. Mus. Comp. Zool., vol. 29, 1896, p. 69.

Discorbina turbo, var. *parisiensis*, subvar. *berthelotiana* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 387, pl. 16. figs. 26, 27.

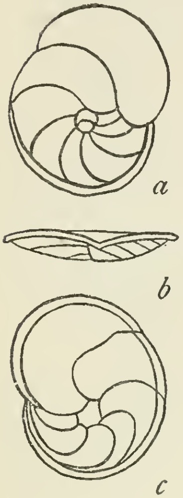


Fig. 23.—Discorbis bertholoti (d'Orbigny). (Adapted from d'Orbigny's figure of the type. *a*, dorsal view; *b*, side view; *c*, ventral view.

Description.—Test oval, plano-convex, much compressed; peripheral margin acute, sometimes slightly carinated; dorsal surface nearly flat, ventral side somewhat convex; chambers five to seven in the final whorl, often slightly carinate at the border; sutures slightly depressed, distinct; wall smooth, punctate; aperture a narrow slit at the inner margin of the chamber on the ventral side.

Diameter 0.40–0.80 mm.

Distribution.—Brady mentions this species as found in the North Pacific but does not give stations. Rhumbler records single specimens both from Chatham Island and Laysan. I have had a few specimens from *Nero* station 990 off Guam in 859 fathoms. It has also occurred at two *Albatross* stations off Japan, D4875 in 59 fathoms and D4946 in 39 fathoms, bottom temperature 68.7° F.

DISCORBIS RARESCENS (H. B. Brady).

Plate 7, fig. 4.

Discorbina rarescens H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 651, pl. 90, figs. 2, 3, and 4.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 388, pl. 15, figs. 45–47.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 136.

Description.—"Test free or adherent, plano-convex; peripheral edge extended so as to form a well-defined keel, often of considerable width; the five segments of the outermost whorl alone visible on the convex face, the last chamber being relatively large, and the sutures even and marked only by fine lines; spiral face somewhat depressed at the umbilicus, the valvular lobes of later segments tolerably distinct.

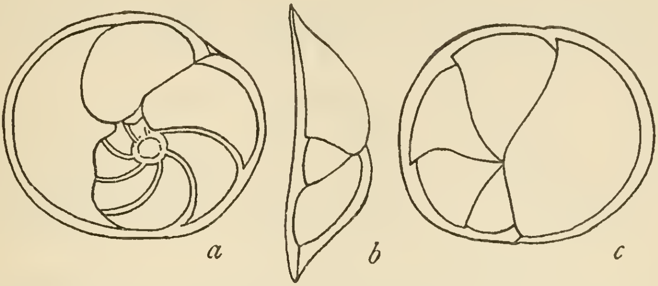


FIG. 24.—DISCORBIS RARESCENS (H. B. BRADY). × 75. (AFTER BRADY.) *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW.

"Diameter 1/40th inch (0.63 mm.)."

Distribution.—The only record for this species in the North Pacific seems to be that of Brady, who records it from the *Challenger* stations off the Philippines in 95 fathoms. The figure and description are from Brady.

DISCORBIS ALLOMORPHINOIDES (Reuss).

Plate 9, fig. 1.

Valvulina allomorphinoides REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 223, pl. 11, fig. 6.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 43, pl. 2, figs. 4, 5.

Discorbina allomorphinoides H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 654, pl. 91, figs. 5, 8.—CHAPMAN, Proc. California Acad. Sci., ser. 3, Geol., vol. 1, 1900, p. 253, pl. 30, fig. 8.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 703.

Pulvinulina allomorphinoides FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 8, 1900, p. 394, fig. 44.

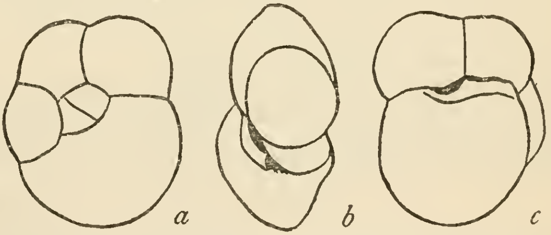


FIG. 25.—DISCORBIS ALLOMORPHINOIDES (REUSS). (ADAPTED FROM REUSS'S FIGURES OF THE TYPE). *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW.

Description.—Test oval, biconvex, ventral side more strongly so; composed of comparatively few chambers, about four in the last formed whorl; peripheral margin broadly rounded; chambers broad;

sutures depressed; wall smooth and finely punctate; aperture an oval opening at the umbilical border of the chamber.

Diameter 0.40–0.85 mm.

Distribution.—No other records exist for the North Pacific for this species other than that of Brady, who obtained it from *Challenger* material off the Philippines in 95 fathoms.

DISCORBIS VENTRICOSA (H. B. Brady).

Plate 13, fig. 1.

Discorbina ventricosa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, 654, pl. 91, figs. 7*a-c*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 392, pl. 15, figs. 54–57.

Description.—"Test free, oblong, rounded, more or less depressed; composed of less than two complete convolutions, the outer whorl consisting of six or seven segments, the successive segments increasing rapidly in length; septal faces ventricose, especially that of the final chamber; sutures excavated. Superior face hispid externally, inferior smooth; umbilicus deeply sunk, valvular flaps but little developed.

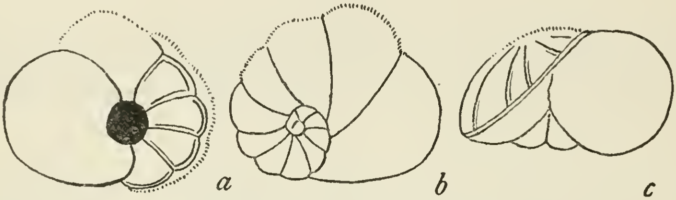


Fig. 26.—Discorbis ventricosa (H. B. Brady). × 50. *a*, ventral view; *b*, dorsal view; *c*, side view. (After type figures by Brady.)

"Diameter about 1/50th inch (0.5 mm.)."

Distribution.—This species has not previously been recorded from the North Pacific. I have a fine typical specimen from *Albatross* station D4922 in 60 fathoms, off Blake Reef, in Colnett or Vincennes Strait, off southern Japan. This extends considerably the previously known range in this region.

This seems to be a very typical species as far as can be judged by the specimen noted above, which is so near like the figure given by Brady that it might almost have been the original of that figure.

DISCORBIS IRREGULARIS (Rhumbler).

Plate 13, figs. 2, 3.

Discorbina irregularis Rhumbler, Zool. Jahrb. Abt. Syst., vol. 24, 1906, p. 70, pl. 5, figs. 57, 58.

Description.—Attached, lower side smooth, flattened, upper side rough, convex, consisting of several coils, the first coil or two regularly spiral with regularly formed chambers, following chambers becoming highly irregular, added finally in concentric rings and losing all trace of a spiral arrangement; aperture of the early chambers typical, a slit between the ventral face of the chamber and the preceding one; in the irregular chambers several apertures on the periphery.

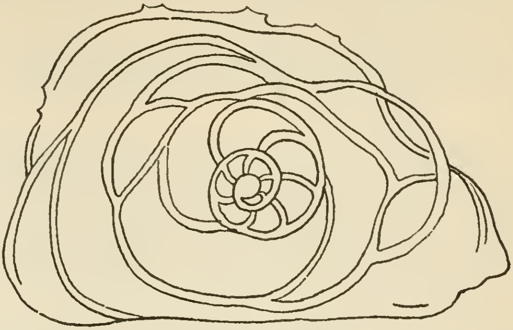


FIG. 27.—DISCORBIS IRREGULARIS RHUMBLER. × 132. (AFTER RHUMBLER'S TYPE FIGURE.)

Diameter 0.38 to 0.52 mm.

Distribution.—Rhumbler described this species from Chatham Island. I have had no material that can be referred unquestionably to this species, which may be a local one.

DISCORBIS SUBFILOSA, new species.

Plate 6, fig. 2.

Description.—Test strongly biconvex, less so ventrally, and umbilicate; chambers few in the final coil, rounded; sutures slightly depressed, rather indistinct; wall ornamented by fine tubules extending through the much thickened wall below, with radiating lines from the umbilicus.

Diameter about 1 mm.

Distribution.—Type-specimen (Cat. No. 9028, U.S.N.M.) from ——.

The surface appearance of this species is very peculiar, arising from the fine tubulation of the wall.

DISCORBIS PULVINULINOIDES, new species.

Plate 6, fig. 3.

Description.—Test biconvex, somewhat flattened above, ventrally rounded, umbilicate, carinate; chambers several, about seven in the last formed whorl; sutures slightly depressed above, more strongly so below; wall smooth above, ventrally with radiating lines extending in toward the umbilicus.

Diameter about 0.5 mm.

Distribution.—Type-specimen (Cat. No. 9029, U.S.N.M.) from *Albatross* station D4875, in 59 fathoms off Japan.

Dorsally, this species is very much like certain species of *Pulvinulina*, but the ventral view shows it to belong to *Discorbis.*

Genus CYMBALOPORA Hagenow, 1850.

Rotalia (part) D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 272.

Rosalina (part) D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 100.

Cymbalopora HAGENOW (type, *C. poeyi* (d'Orbigny)) Bryozoen Maastrichter Kreide, 1850, p. 104.—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 635.

Description.—Test free; early chambers spirally arranged, later ones annular or irregular; umbilicate; wall finely perforate; chambers often not contiguous, but separated from one another by some distance along the periphery, marked on the ventral side by depressions radiating from the central umbilicus; in the various species the early chambers following the proloculum are usually brownish in color, this being wanting in the later adult chambers.

This genus, together with the following one, *Tretomphalus*, has been placed with the Globigerinidæ by some authors. In the general form of the test, especially in the latter genus, there is a striking resemblance, but it seems merely parallelism. The early chambers are decidedly like *Discorbina* in form, wall, aperture, and even in the peculiar brown coloring so characteristic of *Discorbina* and allied genera of the Rotaliidæ.

There seem to be enough differences in form and structure to keep separate the genus *Cymbalopora* from *Tretomphalus*, as has been done by Moebius.

CYMBALOPORA POEYI (d'Orbigny).

Plate 10, fig. 1; plate 14, fig. 5.

Rotalia squamosa D'ORBIGNY (nomen nudum), Ann. Sci. Nat., vol. 7, 1826, p. 272, No. 8.

Rosalina poeyi D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 92, pl. 3, figs. 18–20.

Cymbalopora poeyi CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 215, pl. 13, figs. 10–12.—SCHWAGER, Boll. Com. Geol. Ital., vol. 8, 1877, p. 26, pl., fig. 56.—MOEBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 97, pl. 10, figs. 1–5.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, 1880, p. 202, pl. 9, fig. 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 636, pl. 102, figs. 13*a*–*c*.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 46, fig. 12.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 381, pl. 18, figs. 51, 52.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 280, pl. 6, fig. 3.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 326, pl. 72, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 696.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 71, pl. 5, fig. 59.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 156.

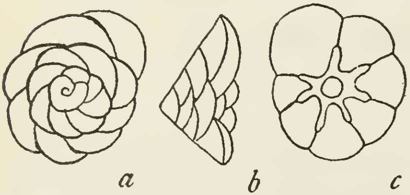


FIG. 28.—CYMBALOPORA POEYI (D'ORBIGNY). *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER D'ORBIGNY.)

Description.—Test free, subconical, apex rounded, concave below, composed of numerous chambers, early ones in a spiral, later ones in concentric rings about the central umbilical cavity, those of one ring alternating with those of the preceding one, all with rather large perforations; aperture of each chamber on the inner side, opening into the central vestibule.

Diameter 0.50–0.85 millimeters.

Distribution.—Brady records the occurrence of this species as from the *Challenger* stations in the North Pacific, depths ranging from 7 to 75 fathoms. Rhumbler records it from Laysan Island. Bagg had the species from five stations in the vicinity of the Hawaiian Islands, depths ranging from 104 to 438 fathoms. I have had material of this species from two stations near the Hawaiian Islands, *Albatross* H3007 in 323 fathoms and *Nero* 2071 in 271 fathoms. Off Japan it occurred at *Albatross* station D4807 in 44 fathoms.

CYMBALOPORA POEYI (d'Orbigny), var. BRADYI, new variety.

Plate 10, fig. 2; plate 14, fig. 2.

Cymbalopora poeyi var. H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 637, pl. 102, fig. 14.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 24.

Description.—Variety differing from the typical form of the species in its much more compressed form and the much more open arrangement of the chambers on the ventral side.

Distribution.—This variety occurred off the Hawaiian Islands, at *Albatross* station H2923 in 392 fathoms.

Type-specimen.—Cat. No. 9030, U.S.N.M.

Brady does not definitely state at what localities he found this variety.

CYMBALOPORA TABELLÆFORMIS H. B. Brady.

Cymbalopora tabellæformis H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 637, pl. 102, figs. 15–18.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 382, pl. 18, figs. 54, 55.—Millett, Journ. Roy. Micr. Soc., 1904, p. 697.

Description.—"Test depressed, peripheral outline rounded or oval; superior face complanate, or nearly so, inferior convex, but with an irregular umbilical cavity or recess; peripheral edge obtuse or rounded. Composed of numerous segments, all of which are visible on the superior face; segments inflated inferiorly, sometimes arranged in more or less regular alternating annuli, but more frequently disposed without apparent order. Shell wall coarsely porous; aperture consisting of a number of large perforations along the lines of the inferior sutural depressions. Colour in fresh shell, brown near the center of the superior face, gradually lighter toward the circumference.

"Diameter 1/25th inch (1 mm.)."

Distribution.—Brady described this species from various stations, among which were two from the North Pacific off the Philippine Islands, 95 fathoms and the Hawaiian Islands, 40 fathoms. I have had frequent specimens from one *Nero* station, 2071 in 271 fathoms off the Hawaiian Islands.

Genus TRETOMPHALUS Moebius, 1880.

Rosalina (part) D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 104.

Cymbalopora (part) CARPENTER, Introd. Foram., 1862, p. 216.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 638.

Tretomphalus MOEBIUS (type, *T. bulloides* (d'Orbigny)), Foram. Mauritius, 1880, p. 98.

Description.—Test free, early stages *Discorbina*-like, in a low conical spire; last formed chamber globular, larger than the entire early growth; wall perforate, the last formed chambers with very large ones; aperture in adult chamber rounded with an entosolenian neck.

The genus *Tretomphalus* seems worthy of distinction from *Cymbalopora* as the development of the final chamber is very different. In its adult form it is found in a pelagic condition, especially in the vicinity of coral reefs. The development of the spherical form and the large pores fitting it for a pelagic life are very analogous to those seen in *Orbulina, Pulvinulina lateralis,* and other forms.

TRETOMPHALUS BULLOIDES (d'Orbigny).

Plate 14, figs. 3, 4.

Rosalina bulloides D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 104, pl. 3, figs. 2–5.

Cymbalopora bulloides CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 216.—H. B. BRADY, Quart. Journ. Micr. Soc., vol. 19, 1879, p. 80; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 638, pl. 102, figs. 7–12, text-figs. 20 *a–c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 381, pl. 18, fig. 53.—EARLAND, Journ. Quekett Micr. Club, ser. 2, vol. 8, 1902, p. 309, pl. 16, figs 6–9.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 697, pl. 7, fig. 4.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 72.

Tretomphalus bulloides MOEBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 98, pl. 10, figs. 6–9.

Discorbina bulloides GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 106, pl. 8, figs. 262, 263.

Description.—Test free, subglobular; early chambers rotaliform, numerous, finely perforate, final chamber very large, inflated, making up the large portion of the test; aperture in the adult composed of numerous circular openings, usually with a single entosolenian neck from the largest.

Diameter 0.60–1.00 mm.

Distribution.—Brady notes the occurrence of this species as pelagic at Zamboanga, Philippine Islands, and at several points in the vicinity of the Hawaiian Islands. He also notes its occurrence as a bottom form in 40 fathoms off the Honolulu coral reefs, Hawaiian Islands. Rhumbler records the species from Laysan Island.

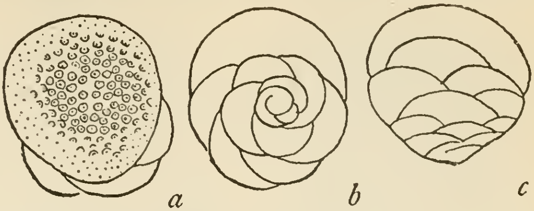


Fig. 29.—Tretomphalus bulloides (d'Orbigny). *a*, ventral view; *b*, dorsal view; *c*, side view. (After d'Orbigny's type figure.)

I have had material from but one station, *Nero* station 12, also near the Hawaiian Islands.

From Brady's notes in the *Challenger* Report apparently both megalospheric and microspheric forms were taken by the *Challenger*.

Genus PLANORBULINA d'Orbigny, 1826.

Planorbulina d'Orbigny (type, *P. mediterranensis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 280.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 655.

Description.—Test typically adherent; early chambers in a close coil, later chambers surrounding the periphery in an annular arrangement; chambers in a single layer; test attached by its dorsal side, noninvolute; all chambers usually visible from either dorsal or ventral side; wall perforate, often rather coarsely so; aperture in the early chambers single on the inner border of the chamber in the coiled chambers, in those arranged in an annular manner usually two, one at either end of the chamber and near the preceding chambers adjacent and together forming a series of apertures about the periphery of the test; each newly added chamber connects with the two adjacent chambers at either side in the series next previously formed.

This genus in its restricted sense includes only those species which have the peculiar annular arrangement of the chambers in adult growth. The number of species is small, most common in the shallow waters of Temperate and Tropical seas.

PLANORBULINA LARVATA Parker and Jones.

Plate 8, fig. 2.

Planorbulina vulgaris d'Orbigny, var. *larvata* Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 294.

Planorbulina larvata Parker and Jones, Philos. Trans., vol. 155, 1865, p. 379, pl. 19, fig. 3*a*, *b*.—Carter, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 214, pl. 13, fig. 16.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 658, pl. 92, figs. 5, 6.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 381, pl. 14, fig. 31.—Millett, Journ. Roy. Micr. Soc., 1904, p. 490.

Description.—Test typically attached, discoidal; chambers of the central portion hidden by the development of thick granules or tubercles on the test making the sutures indistinct; peripheral chambers arranged in annular rings, distinct; sutures somewhat depressed; apertures lipped.

Diameter up to 3 mm.

Distribution.—Brady records this species from the coral reefs of Honolulu, Hawaiian Islands, at a depth of 40 fathoms, and from the Chinese Sea. I have had specimens from Gaspar Straits, collected by the North Pacific Exploring Expedition, Capt. John Rodgers, and from *Albatross* station H4882 in 248 fathoms, bottom temperature 48.8° F. off Blake Reef, in Colnett or Vincennes Strait, off Southern Japan. This is essentially a species of warm shallow waters and it is interesting to find it in this region where so many species of this same general character have appeared.

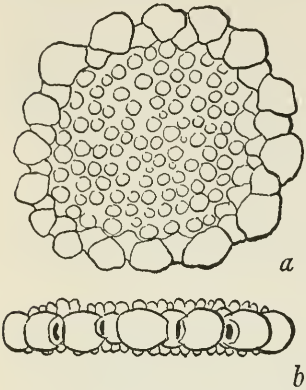


Fig. 30.—Planorbulina larvata Parker and Jones. × 15. (Adapted from Parker and Jones's original figure.) *a*, dorsal view; *b*, side view.

PLANORBULINA MEDITERRANENSIS (d'Orbigny).

Plate 12, fig. 1.

Planorbulina mediterranensis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 280, pl. 14, figs. 4–6; Modèles, No. 79; Foram. Foss. Bass. Tert. Vienne, 1846, p. 166, pl. 9, figs. 15–17.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 31, pl. 2, fig. 74; ser. 4, vol. 8, 1871, p. 178, pl. 12, figs. 133, 134.—Bütschli, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 206, pl. 9. fig. 8.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 656, pl. 92, figs. 1–3.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 45, fig. 18.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 380, pl. 14, figs. 24–26.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 91, pl. 15, fig. 786; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 73.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 328, pl. 72, fig. 6.—Silvestri, Mem. Pont. Acad. Nuovi Lincei, vol. 15, 1899, p. 286, pl. 6, figs. 4–7.—Millett, Journ. Roy. Micr. Soc., 1904, p. 489.—Rhumbler, Zool. Jahrb., Abt. Syst. vol. 24, 1906.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 137.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, 1909, p. 1, pl. 1, figs. 1–3; vol. 54, No. 16, 1910, p. 26.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 419.

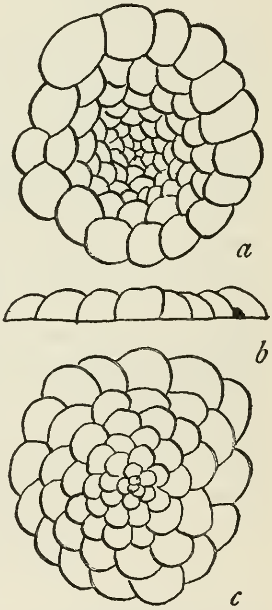


Fig. 31—Planorbulina mediterranensis (d'Orbigny) (Adapted from d'Orbigny's figure of the type.) *a*, ventral view; *b*, side view; *c*, dorsal view.

Planorbulina farcta (Fichtel and Moll) var. *mediterranensis* Parker and Jones. Philos. Trans., vol. 155, 1865, p. 383, pl. 16, fig. 21.

Description.—Test adherent, flattened; early chambers distinctly spiral, later ones less so, often irregularly annular in their arrangement, more or less lobulated in the ventral face; periphery irregular, often angular; wall very conspicuously perforated; early chambers usually with a brownish color, later chambers grayish-white; sutures depressed, often clearly marked on the dorsal face by a distinct band of shell material; apertures at either side of the chamber in the adult, simple, each with a raised lip.

Diameter 1–2 mm. or more.

Distribution.—Rhumbler has recorded this species from shallow water material from both Chatham Island and Laysan. I have had it only from *Nero* station 990 in 859 fathoms, off Guam.

PLANORBULINA ACERVALIS H. B. Brady.

Plate 14, fig. 1.

Planorbulina acervalis H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 657, pl. 92, fig. 4.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 46, fig. 11.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 328, pl. 72, fig. 7.—Millett, Journ. Roy. Micr. Soc., 1904, p. 490.—Rhumbler, Zool. Jahrb., Abteil Syst., vol. 24, 1906, p. 67.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, 1909, p. 2, pl. 1, fig. 4; vol. 54, No. 16, 1910, p. 27.

Description.—Test typically adherent, composed of numerous chambers, early ones spiral, later ones irregularly annular, those of the periphery lobulated, the newly added chambers extending outward a considerable distance beyond the preceding ones; ventral surface often covered by a mass of small acervuline chambers; wall conspicuously porous; apertures lipped.

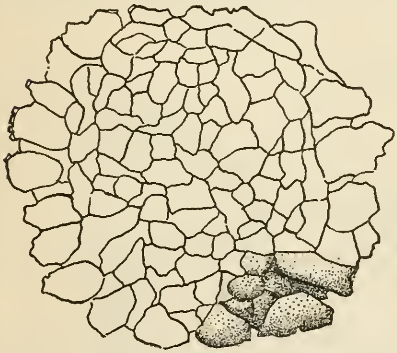


Fig. 32.—Planorbulina acervalis H. B. Brady. ×35. (Adapted from Brady's figure of the type.)

Diameter up to 2.5 mm.

Distribution.—Rhumbler records two specimens of this species from Laysan Island. I have had it from *Nero* station 2071 in 271 fathoms off the Hawaiian Islands, *Nero* station 1466 in 234 fathoms off Guam, and *Albatross* H4882 off Blake Reef in 248 fathoms, bottom temperature 48.8° F. in Colnett or Vincennes Strait, off southern Japan. These are the three areas from which most of the tropical species have occurred in the material I have examined. It is essentially a species of shallow, warm waters.

Genus TRUNCATULINA d'Orbigny, 1826.

Nautilus (part) Walker and Boys, Test. Min., 1784, p. 20.—Walker and Jacob, Adams Essays, Kanmacher's Ed., 1798, p. 642.

Serpula (part) Montagu, Test Brit., 1803, p. 515.

Truncatulina d'Orbigny, (type, *T. lobatula* Walker and Jacob) Ann. Sci. Nat., vol. 7, 1826, p. 279.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 658.

Description.—Test free or adherent, rotaliform, the ventral face usually the more convex but passing into species which are nearly biconvex; chambers usually visible from both sides, occasionally with limbate sutures; wall either smooth or with raised papillæ, occasionally with limbate margins, coarsely puncate; aperture usually a curved slit at the margin of the inner end of the chamber, often with a definite lip.

This genus includes a considerable variety of species and the extreme forms are somewhat dissimilar but as a whole they form a fairly unified genus. Certain groups have at times been segregated with other generic names but except for two species which are here placed under *Siphonina* it seems best to leave them under the genus *Truncatulina*.

TRUNCATULINA REFULGENS (Montfort).

Plate 12, fig. 2.

"Hammonia *Balanus* seu *Balanoidea*," Soldani, Testaceographia, vol. 1, pt. 1, 1789, p. 58, pl. 46, figs. *nn*, *oo*.

Cibicides refulgens Montfort, Conch. Syst., vol. 1, 1808, p. 122.

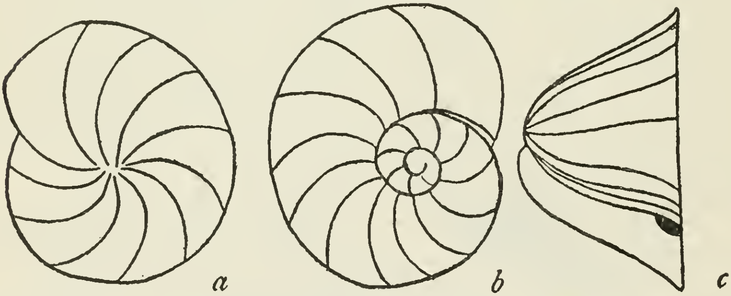


Fig. 33.—Truncatulina refulgens (Montfort). (Adapted from d'Orbigny, 1826.) *a*, ventral view; *b*, dorsal view; *c*, side view.

Truncatulina refulgens d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 279, pl. 13, fig. 8–11; Modèles, No. 77.—Carpenter, Parker, and Jones, Introd. Foram., 1862, p. 201, fig. 32, *E*.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 31, pl. 2, fig. 76.—H. B. Brady, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865–1867 (1867), p. 105, pl. 12, fig. 9*a–c*.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 176, pl. 12, fig. 139.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 197, pl. 3, fig. 40.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 659, pl. 92, figs. 7–9.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 13*a–c*.—Terrigi, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 117, pl. 8, figs. 1–3.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 401, pl. 16, figs. 31–33.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 89, pl. 15, figs. 775, 776.—Jones, Pal. Soc., 1895, p. 302, pl. 5, fig. 31.—Chapman, Journ. Roy. Micr. Sec., 1898, p. 1, pl. 1, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1904, p. 491.—Chapman, Journ. Qnekett Micr. Club, ser. 2, vol. 10, 1907, p. 137.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 2.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 284; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 420.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 83.

Description.—Test usually free, ventral face flattened or concave, dorsal face strongly convex; peripheral margin sharp, keeled; chambers numerous, 7–9 in final whorl, all visible from the ventral face, only those of the last-formed whorl visible from the dorsal face; sutures slightly depressed, somewhat limbate; wall fairly smooth, punctate; aperture a narrow slit at the inner margin of the chamber.

Diameter up to 1.4 mm.

Distribution.—Bagg records this species from several *Albatross* stations off the Hawaiian Islands at depths ranging from 104 to 1,544 fathoms. I have had the species from several *Albatross* stations in the same region, depths ranging from 373 to 607 fathoms. At *Albatross* station H2768 in 373 fathoms the species was represented by abundant specimens. It also was noted from *Nero* station 1328 in 871 fathoms between Guam and Yokohama.

TRUNCATULINA LOBATULA (Walker and Jacob).

Plate 15, fig. 1.

"Nautilus spiralis lobatus, etc." Walker and Boys, Test. Min., 1784, p. 20, pl. 3, fig. 71.

"Hammoniæ tuberculatæ, etc." Soldani, Testaceographia, vol. 1, pt. 1, 1789, p. 58, pl. 45, figs. *ii, kk, ll, mm*.

Nautilus lobatulus Walker and Jacob, Adams Essays, Kanmacher's ed., 1798, p. 642, pl. 14, fig. 36.

Serpula lobatula Montagu, Test. Brit., 1803, p. 515, Suppl., p. 160.

Truncatulina lobatula d'Orbigny, in Barker, Webb and Berthelot, Hist. Nat. Îsles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 134, pl. 2, figs. 22–24; Foram. Foss. Bass. Tert. Vienne, 1846, p. 168, pl. 9, figs. 18–23.—Egger, Neues Jahrb. für Min., 1857, p. 279, pl. 9, figs. 1–3.—Parker and Jones, Ann. Mag. Nat. Hist. ser. 2, vol. 19, 1857, p. 293, pl. 10, figs. 17–21.—Williamson, Rec. Foram. Great Britain, 1858, p. 59, pl. 5, figs. 121–123.—Jones, Parker, and H. B. Brady, Mon. Foram. Crag, 1866, pl. 2, figs. 4–10, pl. 4, fig. 18.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 176, pl. 12, fig. 136.—Schwager, Boll. R. Com. geol. Ital., vol. 8, 1877, p. 26, pl., fig. 49.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 205, pl. 3, fig. 57.—Terquem, Mem. Soc. géol. France, ser. 3, vol. 2, 1882, p. 94, pl. 9, fig. (27), fig. 27*a, b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 660, pl. 92, fig. 10; pl. 93, figs. 1, 4, 5; pl. 95, figs. 4, 5.—Sherborn and Chapman Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 12*a–c*.—Malagoli, Atti Soc. Nat. Modena (Rend.), ser. 3, vol. 3, 1887, p. 110, pl. 1, fig. 14.—

H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 42, fig. 20; pl. 45, fig. 26.—Terrigi, Mem. R. Acad. Lincei, ser. 4, vol. 6, 1889, p. 116, pl. 7, figs. 5–7.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 396, pl. 16, figs. 1–3, 10–12.—Fornasini, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 3, 1893, p. 435, pl. 2, figs. 15, 16.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 88, pl. 15, fig. 774.—Burrows and Holland, Proc. Geol. Assoc., vol. 15, 1897, p. 47, pl. 2, fig. 24.—Morton, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 120.—Chapman, Journ. Roy. Micr. Soc., 1898, p. 2, pl. 1, fig. 2.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 333, pl. 76, fig. 4.—Chapman, Proc. Roy. Soc. Edinburgh, vol. 23, 1902, p. 392, pl. 1, figs. 2, 3.—Millett, Journ. Roy. Micr. Soc., 1904, p. 491.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 103; Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 137.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.—Cushman, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 30.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 2.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 284; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 420.—Bagg, Bull. U. S. Geol. Surv. No. 513, 1912, p. 82, pl. 24, figs. 9–14.

Planorbulina farcata, var. (*Truncatulina*) *lobatula* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 381, pl. 14, figs. 3–6; pl. 16, figs. 18–20.

Planorbulina lobatula Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 88, pl. 15, fig. 774.

Description.—Test typically adherent, plano-convex, ventral face flattened, dorsal face moderately convex; peripheral margin rounded; chambers numerous, usually seven in the last formed coil; sutures somewhat depressed; wall usually fairly smooth, coarsely punctate or sometimes ornamented with ridges or bosses; aperture a narrow slit at the inner margin of the chamber.

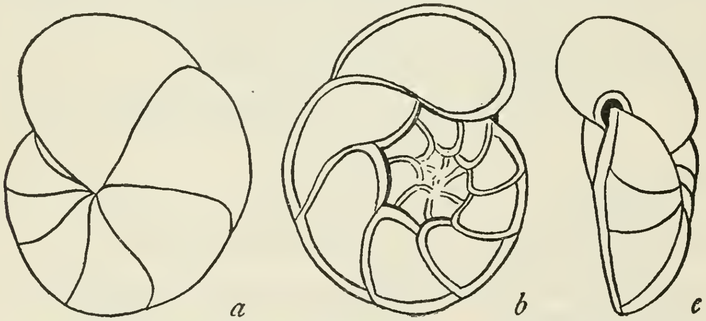


Fig. 34.—Truncatulina lobatula (Walker and Jacob). (Adapted from Brady.) *a*, ventral view; *b*, dorsal view; *c*, side view.

Diameter up to 1.2 mm.

Distribution.—This species is recorded at *Challenger* station 206 in 2,100 fathoms. Bagg records it from 12 *Albatross* stations off the Hawaiian Islands, depths ranging from 104 to 1,307 fathoms. I have had specimens from the latter region, *Albatross* H2932 in 20 fathoms and H2923 in 392 fathoms. It occurred fairly frequently in material from the stomachs of Holothurians dredged at *Albatross* D3603 in 1,771 fathoms, Bering Sea. At *Nero* station 1464, near Guam in 891 fathoms, a single specimen occurred, and it was found in material from *Nero* stations 1012 in 1,932 fathoms and 1222 in 726 fathoms between Guam and Yokohama. It also occurred in shallow water material off Hakodate, Japan.

This is a very common species in shallow water of the cooler parts of the oceans, but little material from such localities was available in this work.

TRUNCATULINA VARIABILIS d'Orbigny.

"Testæ hammoniformes, *plano-cochleatæ, tuberosæ articulatæ,* etc." Soldani, Testaceographia, vol. 1, pt. 1, 1789, pp. 77–80, pls. 70–92.

Truncatulina variabilis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 279, No. 8; in Barker, Webb, and Berthelot, Hist. Nat. Îsles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 135, pl. 2, fig. 29.—Reuss, Denkschr. Akad. Wiss. Wien, vol. 23, 1864, p. 10, pl. 1, fig. 15.—Terquem, Mém. Soc. Géol. France, ser. 3, vol. 1, Mém. 3, 1878, p. 20, pl. 1, fig. 18–25; vol. 2, 1882, p. 92, pl. 9 (17), figs. 22–25.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 661, pl. 93, figs. 6–7.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 45, fig. 17.—Terrigi, Mem. R. Accad. Lincei, ser. 4, vol. 6, 1889, p. 116, pl. 7, figs. 8, 9.—Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 562, pl. 11, fig. 22.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 404, pl. 16, figs. 57–59, 63, 64.—Jones, Pal. Soc., 1896, p. 309, pl. 6, fig. 23.—Millett, Journ. Roy. Micr. Soc., 1904, p. 492.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 103.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 2, pl. 1, figs. 5, 6; pl. 2, figs. 1–3.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 285.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 27.—Bagg, Bull. U. S. Geol. Survey, No. 513, 1912, p. 84, pl. 24, figs. 1–4; pl. 25, figs. 4, 5.

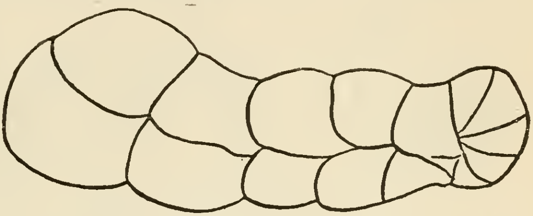


Fig. 35.—Truncatulina variabilis d'Orbigny. × 100.

Planorbulina variabilis Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 88.

Description.—Test adherent, elongated, irregular in shape, dorsal side convex, ventral side in early portion concave, later variously shaped; peripheral margin rounded; chambers numerous, early ones coiled, later ones linear, biserial or irregularly arranged to form an elongate test; sutures somewhat depressed, distinct; wall coarsely punctate.

Length up to 1.75 mm.

Distribution.—Apparently this species has not previously been recorded from the North Pacific. I have had material from *Albatross* station H2923 in 392 fathoms off the Hawaiian Islands and from *Nero* station 1310 in 518 fathoms between Guam and Yokohama.

This species presents various modifications of shape in its later growth.

TRUNCATULINA WUELLERSTORFI (Schwager).

Plate 12, fig. 3.

Anomalina wuellerstorfi Schwager, *Novara* Exped., geol. Theil., vol. 2, 1866, p. 258, pl. 7, figs. 105, 107.

Truncatulina wuellerstorfi H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 662, pl. 93, figs. 8, 9.—Uhlig, Jahrb. k. k. geol. Reichs., vol. 36, 1886, p. 174, fig. 3.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 397, pl. 16, figs. 13–15.—Chapman, Journ. Roy. Micr. Soc., 1893, p. 3, pl. 1, fig. 3.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 333, pl. 77, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1904, p. 492.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 102.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 159.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 285; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 420.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 84, pl. 25, figs. 10*a–c*, 11*a–c*.

Planorbulina wuellerstorfi Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 89, pl. 15, fig. 777.

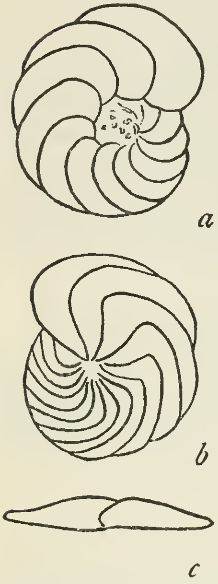


Fig. 36.—Truncatulina wuellerstorfi (Schwager). Adapted from Schwager.) *a*, dorsal view; *b*, ventral view; *c*, side view.

Description.—Test usually free, much compressed, dorsal side slightly convex, ventral side flattened; chambers numerous, elongate, curved, 9 or 10 in the last formed coil; sutures limbate; periphery usually bluntly rounded; wall very coarsely punctate; aperture a curved, arched opening at the periphery of the chamber.

Diameter up to 1.40 mm.

Distribution.—From the available records this seems to be one of the most common species in the North Pacific. Brady in the *Challenger* Report records it from three North Pacific stations in 345 to 2,050 fathoms. Goës records it from seven *Albatross* stations in the western tropical Pacific at depths ranging from 660 to 1,201 fathoms. Flint records it from *Albatross* station D2805 in 51 fathoms in Panama Bay. Bagg records it from 14 out of 19 *Albatross* stations off the Hawaiian Islands, depths ranging from 275 to 1,544 fathoms.

I have had material of this species from many stations well scattered over the North Pacific; from off the coast of Washington, *Albatross* D3346 in 786 fathoms, common; off the Galapagos D2806 in 1,379 fathoms, off the Hawaiian Islands between the Hawaiian and Midway Islands and especially at a larger number of stations between Guam and Yokohama. These last stations range in depth from 665 to 2,391 fathoms.

TRUNCATULINA HAIDINGERII (d'Orbigny).

Plate 13, fig. 5; plate 28, fig. 1.

Rotalina haidingerii D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 154, pl. 8, figs. 7–9.

Planorbulina haidingerii H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 469, pl. 48, fig. 11.

Truncatulina haidingerii REUSS, Sitz. kais. Akad. Wiss. Wien, vol. 55, 1867. p. 28.—TERRIGI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 118, pl. 8, figs. 7–9.—EGGER, Abh. kön. bay. Akad. Wiss. Munchen, Cl. II, vol. 18, 1893, p. 401, pl. 16, figs. 25–27.—LIEBUS, Jahrb. k. k. geol. Reichs., vol. 52, Heft 1, 1902, p. 90, fig. 4.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 493.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 104; Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 137.—BAGG. Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 420.

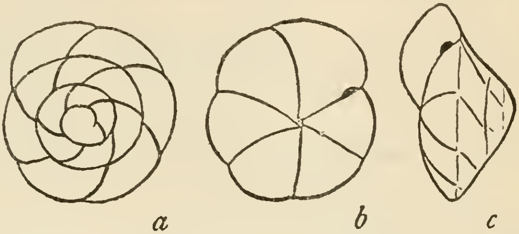


FIG. 37.—TRUNCATULINA HAIDINGERII (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S TYPE FIGURE.) *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, SIDE VIEW.

Planorbulina farcata, var. *haidingerii* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 382, pl. 16, fig. 22*a*, *b*.

Description.—Test free, biconvex; peripheral margin rounded; chambers numerous, broad, about nine in the last formed coil; sutures distinct but not depressed; wall smooth, finely punctate; aperture a small opening at the ventral margin of the chamber.

Diameter up to 1.2 mm.

Distribution.—The only previously recorded station for this species in the North Pacific is one recorded by Bagg, *Albatross* H4508 in 495 fathoms off the Hawaiian Islands. I have had the species from H4878 in 84 fathoms, bottom temperature 51.9° F., D4946 in 39 fathoms, bottom temperature 68.7° F. and also from D4822 in 130 fathoms, bottom temperature 39.4° F., all off Japan.

TRUNCATULINA AKNERIANA (d'Orbigny).

Plate 16, fig. 3.

Rotalina akneriana D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 156, pl. 8, figs. 13–15.

Truncatulina akneriana REUSS, Denkschr. kais. Akad. Wiss. Wien, vol. 25, 1866, p. 160, No. 6.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 663, pl. 94, fig. 8*a–c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 400, pl. 16, figs. 60–62.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 333, pl. 77, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 494.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 103.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 420.

Planorbulina akneriana GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 89, pl. 15, figs. 778, 779.

Description.—Test free, biconvex; peripheral margin broadly rounded; dorsal surface convex at the margin, depressed or flattened toward the center, ventral surface convex but less so toward the center; chambers numerous, about 11–13 in the final coil, broad, short; sutures strongly limbate, ventrally depressed, sutures between last few chambers and the previous coil deep and distinct; surface very coarsely punctate; aperture an arched slit at the periphery.

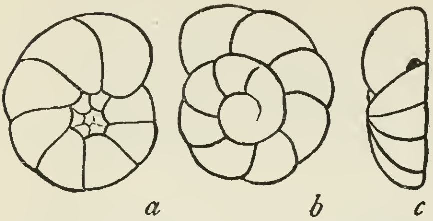


Fig. 38.—Truncatulina akneriana (d'Orbigny). (Adapted from d'Orbigny's type figure.) *a*, ventral view; *b*, dorsal view; *c*, side view.

Diameter up to 1.25 mm.

Distribution.—The only North Pacific record for this species is given by Bagg, *Albatross* station H4590 in 978 fathoms off the Hawaiian Islands.

I have had a single specimen from *Albatross* H2922 also off the Hawaiian Islands.

TRUNCATULINA UNGERIANA (d'Orbigny).

Plate 17, fig. 2.

Rotalina ungeriana d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 157, pl. 8, figs. 16–18.

Planorbulina ungeriana H. B. Brady, Trans. Linn. Soc. London, vol. 24, 1864, p. 469, pl. 48, fig. 12.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 757, pl. 16, fig. 16.—Göes, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 90, pl. 15, fig. 780.

Truncatulina ungeriana Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 161.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 664, pl. 94, fig. 9*a–d*.—Terrigi, Mem. R. Accad. Lincei, ser. 4, vol. 6, 1889, p. 117, pl. 8, fig. 4; Mem. R. Com. geol. d'Italia, vol. 4, 1891, p. 106, pl. 4, fig. 9.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, pl. 16, figs. 19–21.—Silvestri, Mem. Pont. Accad. Nuovi Lincei, vol. 9, 1893, p. 213, pl. 6, fig. 3.—Burrows and Holland, Proc. Geol. Ass., vol. 15, 1897, p. 47, pl. 2, fig. 23.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 333, pl. 77, fig. 2.—Millett, Journ. Roy. Micr. Soc., 1904, p. 493.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 103; Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 138; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 285; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 420.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 83, pl. 25, figs. 1–3.

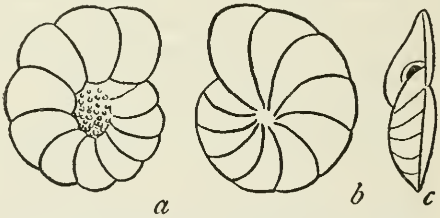


Fig. 39.—Truncatulina ungeriana (d'Orbigny). (Adapted from d'Orbigny's type figure.) *a*, dorsal view; *b*, ventral view; *c*, side view.

Planorbulina farcata, var. *ungeriana* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 382, pl. 16, figs. 23–25.

Description.—Test free, biconvex but unequally so; peripheral margin acute, subcarinate; chambers numerous, 10 to 12 in the final whorl, short and broad; sutures distinct, somewhat depressed; wall rather coarsely punctate, especially on the dorsal surface; aperture a narrow arched opening on the periphery of the test.

Diameter up to 1.25 mm.

Distribution.—The only previously recorded station for this species in the North Pacific is one given by Brady from the *Challenger* material in 2,300 fathoms. I have had specimens from numerous stations, off the Hawaiian Islands, off Guam and between Guam and Japan, depths ranging from 276 to 1,588 fathoms.

TRUNCATULINA TENERA H. B. Brady.

Plate 16, fig. 2; plate 23, fig. 6.

Truncatulina tenera H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 665, pl. 95, figs. 11*a–c*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 402, pl. 16, figs. 45–47.

Description.—"Test regularly Rotaliform; both faces convex, peripheral edge acute and lobulated. Consisting of rather more than three convolutions of nearly equal width, the last of which is formed of five or six segments; sutures distinct, slightly depressed, marked on the superior face by nearly straight radial lines; aperture a curved fissure bordered by a thickened lip, situated at the inner margin of the final segment near the periphery.

"Diameter 1/55th inch (0.46 mm.)."

Distribution.—Apparently this species has not been previously recorded from the North Pacific. The only material of the species which I have had is from *Albatross* station D4951 in 703 fathoms, bottom temperature 37.7° F., off Japan.

The material is very typical. The above description is from Brady.

TRUNCATULINA DUTEMPLEI (d'Orbigny).

Plate 15, fig. 2.

Rotalina dutemplei d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 157, pl. 8, figs. 19–21.

Truncatulina dutemplei Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 160, pl. 4, fig. 16.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 665, pl. 95, fig. 5*a–c*.—Terrigi, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 118, pl. 8, figs. 10, 11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 400, pl. 16, figs. 22, 23, 30, 54–56.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 421.

Description.—Test free, dorsal surface flattened at the sides, umbonate in the center, ventral surface convex; chambers about six in the last formed coil; peripheral margin broadly rounded; sutures slightly depressed, but very distinct; wall rather coarsely punctate, especially the last few chambers; aperture a small arched opening ventrally from the periphery of the chamber.

Diameter 0.40–0.75 mm.

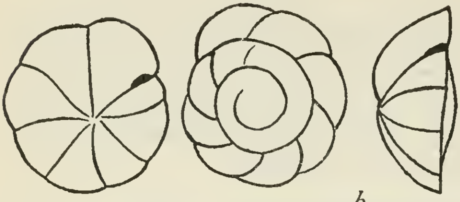


FIG. 40.—TRUNCATULINA DUTEMPLEI (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S TYPE FIGURE.) *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW.

Distribution.—Bagg records the only previously published station for this species in the North Pacific, *Albatross* H4571 in 384 fathoms off the Hawaiian Islands. I have had specimens referable to this species from two *Nero* stations, 1294 in 1,417 fathoms and 1,310 in 518 fathoms between Guam and Japan. It has also occurred at *Albatross* station H4882 in 248 fathoms, bottom temperature 48.8° F., off Blake Reef, in Colnett or Vincennes Strait, Southern Japan.

TRUNCATULINA TUMIDULA H. B. Brady.

Plate 15, fig. 3.

Truncatulina tumidula H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol 9, 1884, p. 666, pl. 95, figs. 8*a–d*.

Description.—"Test trochoid, more or less depressed, consisting of three convolutions, the last of which is composed of about six segments; superior face highly convex; inferior less convex, slightly excavated at the umbilicus; peripheral edge thick and lobulated; segments inflated, especially those of the final convolution. Colour deep brown, except the terminal segment, which is generally of lighter hue.

"Diameter 1/30th inch (0.2 mm.)."

Distribution.—Brady described this small species from a *Challenger* station near the Canaries. I have had material from two *Nero* stations between Guam and Japan that very closely resemble the figures of *T. tumidula* and seem to be identical with it. These are *Nero* stations 1160 in 1,907 fathoms and 1294 in 1,417 fathoms.

TRUNCATULINA PYGMEA Hantken.

Truncatulina pygmea HANTKEN, Mitth. Jahrb. ung. geol. Anstalt., vol. 4, 1875, p. 78, pl. 10, fig. 8.

Truncatulina pygmea H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 666, pl. 95, figs. 9, 10.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 400, pl. 16, figs. 24, 28, 29.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1906, p. 103.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 421.

Description.—Test free, biconvex; peripheral margin bluntly rounded; chambers numerous, angled on the dorsal side, about nine in the last-formed whorl; sutures very distinct, limbate, especially on the dorsal side with clear shell material, most distinct in the last-formed whorl; aperture an elongate slit at the inner margin of the chamber, ventrally from the periphery.

Diameter 0.30–0.65 mm.

Distribution.—In the *Challenger* Report Brady records this species from five stations in the North Pacific ranging in depth from 1,850 to 3,125 fathoms. Bagg records it from one *Albatross* station, H4502 in 1,342 fathoms off the Hawaiian Islands.

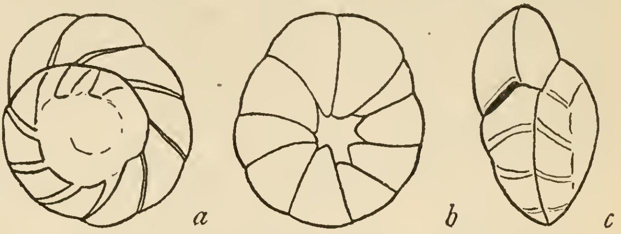


FIG. 41.—TRUNCATULINA PYGMAEA HANTKEN. (ADAPTED FROM BRADY.) *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, SIDE VIEW.

I have had material of this species from several *Nero* stations, 10 in 2,098 fathoms, 124 in 1,726 fathoms, 990 at Guam in 859 fathoms and several stations between Guam and Yokohama, depths ranging from 1,088 to 2,180 fathoms.

From all the North Pacific records this species seems to occur most frequently at depths over 1,500 fathoms.

TRUNCATULINA PRÆCINCTA (Karrer).

Plate 26, fig. 2.

Rotalia præcincta KARRER, Sitz. Akad. Wiss. Wien, vol. 58, 1868, p. 189, pl. 5, fig. 7.—SEGUENZA, Atti Accad. Lincei, ser. 3, vol. 6, 1897, pp. 56, 64.

Truncatulina præcincta H. B. BRADY, Rep. Voy *Challenger*, Zoology, vol. 9, 1884, p. 667, pl. 95, figs. 1–3.—TERRIGI, Mem. Com. geol. Italia, vol. 4, 1891, p. 107, pl. 4, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 403, pl. 16, figs. 51–53.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 5, 1895, p. 12, pl. 4, fig. 36.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 334, pl. 78, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 494.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 104.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.

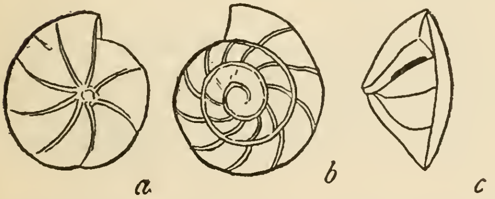


FIG. 42.—TRUNCATULINA PRÆCINCTA (KARRER). (ADAPTED FROM KARRER'S TYPE FIGURE.) *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW.

Description.—Test free, ventral side strongly convex, dorsal side but slightly so; comparatively large, peripheral margin bluntly rounded; chambers very numerous, about twelve in the last-formed whorl, short and broad, especially on the dorsal side where four or more whorls may be visible, slightly oblique; sutures and periphery marked by clear shell material often appearing as distinct ridges most marked toward the umbilicus, remaining portion of surface finely but distinctly punctate; aperture a narrow slit on the inner margin of the chamber ventrally from the peripheral margin.

Diameter up to 1.5 mm.

Distribution.—Brady records this from the *Challenger* station off the Philippines in 95 fathoms. Bagg records it from a single *Albatross* station, H4476 in 438 fathoms off the Hawaiian Islands. I have it from a single station in the same region *Albatross* H2683 in 770 fathoms, a few poor specimens, and from *Albatross* D4874 in 66 fathoms off Japan.

TRUNCATULINA MARGARITIFERA H. B. Brady.

Plate 17, fig. 1.

Truncatulina margaritifera H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 66; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 667, pl. 96, fig. 2 *a–c*.

Description.—"Test Rotaliform; superior face slightly convex or nearly flat, inferior convex; peripheral edge sharp, subcarinate, more or less lobulated; consisting of three convolutions, of which the last has about twelve segments; segments all visible on the superior face, only those of the final convolution on the inferior. Sutural lines on both faces marked by rows of exogenous beads of clear shell-substance, largest near the center of the test; walls conspicuously foraminated.

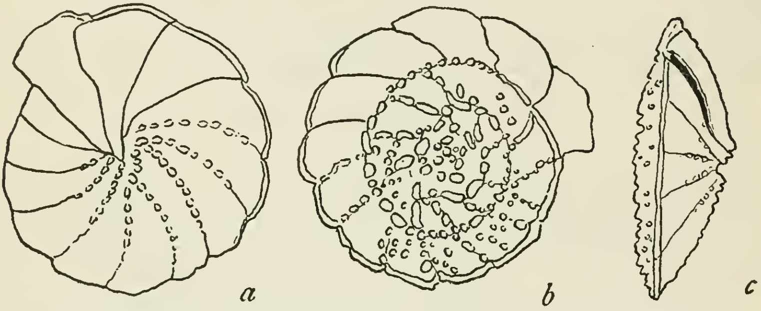


FIG. 43.—TRUNCATULINA MARGARITIFERA H. B. BRADY. (ADAPTED FROM BRADY'S TYPE FIGURE. × 28. *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW.

"Diameter 1/20th inch (1.27 mm)."

Distribution.—The only published North Pacific record for this species is that of Brady from the *Challenger* station off the Philippines in 95 fathoms. Apparently this belongs to the fauna already several times mentioned which in the North Pacific reaches into the Philippine Archipelago from the south and farther north to Japan as it was found at *Albatross* station D4874 in 66 fathoms and D4946 in 39 fathoms, bottom temperature 68.7° F.

The Japanese specimens were in every way typical and of good size.

TRUNCATULINA CULTER (Parker and Jones).

Plate 16, fig. 1.

Planorbulina culter Parker and Jones, Philos. Trans., vol. 155, 1865, p. 421, pl. 19, fig. 1 *a*, *b*.

Truncatulina culter H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 668, pl. 96, fig. 3 *a–c*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 401, pl. 16, figs. 16–18.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 421.

Description.—Test free, ventrally strongly convex, dorsally flattened or very slightly convex; peripheral margin acute, often carinate, slightly fimbriate; chambers numerous, oblique above, ten or more in the final whorl; sutures limbate, in the earlier whorls becoming very much thickened, in the later ones less so; surface of the test finely punctate; sutures rather indistinct below; aperture an arched or almost comma-shaped opening at the inner margin of the chamber about half way between the peripheral margin and the umbilicus.

Diameter 0.40–0.80 mm.

Distribution.—The only North Pacific records for this species are those given by Bagg, *Albatross* H4502 in 1,342 fathoms and H4567 in 1,307 fathoms off the Hawaiian Islands. I have had no material which I could refer to this species.

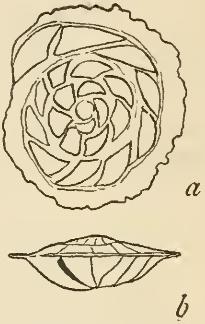


Fig. 44.—Truncatulina culter Parker and Jones. (Adapted from Parker and Jones's type figure.) × 25. *a*, dorsal view; *c*, side view.

TRUNCATULINA MUNDULA H. B. Brady, Parker, and Jones.

Plate 13, fig. 4.

Truncatulina, sp. H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 95, fig. 6.

Truncatulina mundula H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 228, pl. 45, fig. 25.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.

Planorbulina mundula Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 71.

Description.—Test free, almost equally biconvex; peripheral margin acutely rounded; chambers numerous, 12 to 14 in the last-formed coil; sutures oblique dorsally; margins of chambers of clear shell material, raised and thickened in the earlier coils, almost hiding the original surface of the chamber and broad even in the last-formed chambers, remainder of the surface distinctly foraminated; ventral side with the sutures indistinct, with little or no trace of thickenings; walls very coarsely foraminated; aperture a narrow slit extending ventrally from the peripheral margin.

Diameter up to 1.0 mm.

Distribution.—Goës records this species from two *Albatross* stations, D3353, in 695 fathoms and D3433, in 1,218 fathoms, in the western tropical Pacific. Bagg records it from a single *Albatross* station, D4000, in 104–213 fathoms, off the Hawaiian Islands.

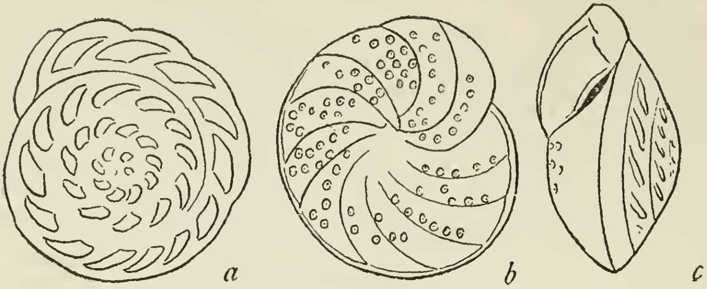


Fig. 45.—Truncatulina mundula H. B. Brady, Parker and Jones. (Adapted from Brady's figure.) × 40. *a*, dorsal view; *b*, ventral view; *c*, side view.

Genus SIPHONINA Reuss, 1849.

Rotalia (part) Czjzek, Haidinger's Nat. Abh., vol. 2, 1848, p. 145.

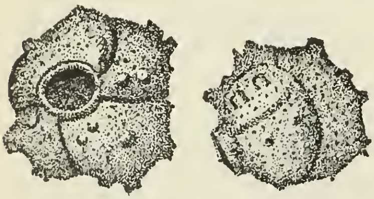
Siphonina, Reuss (type, *S. reticulata* (Czjzek)), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 372.

Planorbulina (part) Parker and Jones, Philos. Trans., vol. 155, 1865, p. 379.

Truncatulina (part) H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 669.

Description.—Test free, composed of numerous chambers arranged in a somewhat irregular spiral, rounded or biconvex, perforate; wall smooth or ornamented; aperture rounded, usually with a short neck and phialine lip.

This genus seems to be worthy of separation from *Truncatulina* by its apertural characters alone. There are two North Pacific species which are here described.



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Figs. 46, 47.—Siphonina echinata (H. B. Brady). × 100. (After Brady.)

SIPHONINA ECHINATA (H. B. Brady).

Plate 18, figs. 1–4.

Planorbulina echinata H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 69, pl. 8, fig. 31*a–c*.

Truncatulina echinata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 670, pl. 96, figs. 9–14.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 403, pl. 16, figs. 40, 41.

Description.—"Test nearly spherical; consisting of about two convolutions, of which the outermost is composed of four segments; segments ventricose, unequally arched, embracing. Shell coarsely perforated and usually more or less beset with short, blunt spines or tubercles. Aperture large and rounded; bordered by a thickened rim or forming a short, wide neck; often partially closed within by a shelly plate.

"Diameter 1/80th inch (0.32 mm.)."

Distribution.—Brady gives the only recorded station for this species in the North Pacific, that of the *Challenger* off the coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms.

SIPHONINA RETICULATA (Czjzek).

Plate 16, fig. 4; plate 28, fig. 3.

Rotalina reticulata Czjzek, Haidinger's Nat. Abh., vol. 2, 1848, p. 145, pl. 13, figs. 7–9.

Siphonina reticulata Bronn, Lethaea Geognostica, ed. 3, vol. 3, 1853–1856, p. 227, pl. 35(?), figs. 23*a*–*c*.

Truncatulina reticulata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 669, pl. 96, figs. 5–8.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 228, pl. 45, figs. 23, 24.—Terrigi, Mem. Com. Geol. Italia, vol. 4, 1891, p. 107, pl. 4, fig. 10.—Chaster, First Rept. Southport Soc. Nat. Sci., 1890–1891 (1892), p. 66, pl. 1, fig. 16.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 402, pl. 16, figs. 42–44.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 334, pl. 78, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1904, p. 491.—Chapman, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 102; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 27.

Siphonina fimbriata Reuss, Denkschr. Akad. Wiss. Wien, 1849, p. 372, pl. 47, fig. 6.

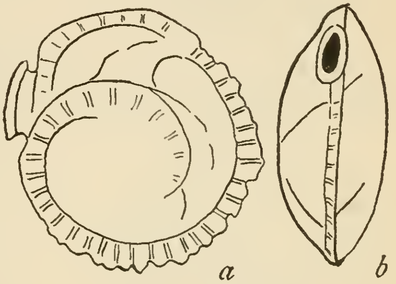

Fig. 48.—Siphonina reticulata (Czjzek). ×100. *a*, side view; *b*, apertural view. (Adapted from Brady.)

Description.—Test free, nearly circular, biconvex, the two sides about equally so; peripheral margin acute and carinate, in small specimens with large carinal tubuli giving a serrate periphery, less irregular in adult specimens; chambers numerous, arranged in a rotaliform manner, thick-walled, translucent, distinctly punctate; aperture elliptical, with a definite tubular neck and phialine lip.

Diameter 0.50 to 0.75 mm.

Distribution.—The only material of this species I have recorded came from two *Albatross* stations off Japan, D4887, in 71 fathoms, bottom temperature 59.7° F., and D4949, in 110 fathoms, bottom temperature 57.8° F.

Genus ANOMALINA d'Orbigny, 1826.

Anomalina D'ORBIGNY (type, *A. punctulata* d'Orbigny), Modèles, 1826, No. 67, p. 282.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 671.

Description.—Test nautiloid, composed of numerous chambers, but slightly involute; the two faces usually much alike, biconvex or slightly unsymmetrical; aperture a narrow curved slit at the base of the final chamber.

This genus consists of but few living species. It is distinguished from *Truncatulina*, mainly, by the biconvex character of the test.

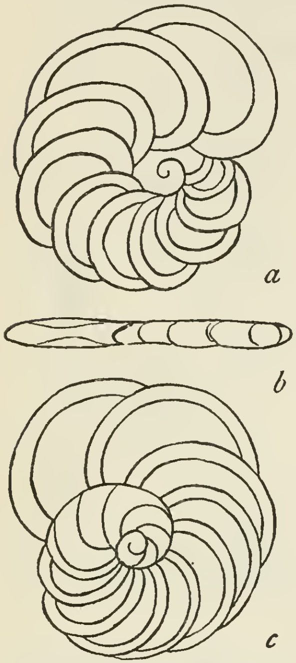

FIG. 49.—ANOMALINA ARIMINENSIS (D'ORBIGNY). (FROM D'ORBIGNY'S TYPE FIGURES OF 1826.) *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW.

ANOMALINA ARIMINENSIS (d'Orbigny).

Plate 19, fig. 1.

Planulina ariminensis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 280, pl. 14, fig. 1–3; Modèles, No. 49.

Anomalina ariminensis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 674, pl. 93, figs. 10, 11.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 228, pl. 45, figs. 20–22.—TERRIGI, Mem. Com. Geol. Italia, vol. 4, 1891, p. 107, pl. 4, fig. 12.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 5, 1895, p. 13, pl. 4, fig. 37.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 335, pl. 79, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 495.

Planorbulina ariminensis G. M. DAWSON, Can. Nat., ser. 2, vol. 7, 1874, p. 253, fig. *d*.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 91, pl. 15, figs. 784, 785.

Planorbulina tuberosa, var. *ariminensis* GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 98, pl. 7, figs. 228–233.

Description.—Test much compressed laterally, composed of numerous chambers all clearly visible from the dorsal side, and a part from the ventral side besides the last formed coil, nine or ten chambers in the last formed coil, chambers becoming elongate, comma-shaped; the sutures limbate; periphery squarely angled; wall coarsely perforate; aperture somewhat oblique on the ventral half of the chamber in face view.

Diameter about 0.6–1.2 mm.

Distribution.—Brady records this species from Hongkong Harbor. Bagg had it from two *Albatross* stations H4430 in 1,544 fathoms and H4567 in 1,307 fathoms off the Hawaiian Islands.

I have had typical specimens from but few stations, *Albatross* D3346 in 786 fathoms off the coast of Oregon and *Nero* 1065 in 1,321 fathoms between Guam and Japan.

ANOMALINA GROSSERUGOSA (Gümbel).

Plate 20, fig. 1.

Truncatulina grosserugosa Gümbel, Abh. kais. bay. Akad. Wiss., vol. 10, 1868, p. 660, pl. 2, fig. 104.—Terrigi, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 117, pl. 8, fig. 5.

Anomalina grosserugosa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 673, pl. 94, figs. 4, 5.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1889, p. 487, pl. 11, fig. 34.—Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 563, pl. 11, fig. 25.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 378, pl. 14, fig. 4–6.—Burrows and Holland, Proc. Geol. Ass., vol. 15, 1897, p. 48, pl. 2, fig. 26.—Bagg, Bull. U. S. Geol. Survey, No. 88, 1898, p. 67, pl. 6, fig. 4.—Flint, Rep. U. S. Nat. Mus., 1899, p. 335, pl. 78, fig. 5.—Chapman, Proc. California Acad. Sci., ser. 3, Geol., vol. 1, 1900, p. 253, pl. 30, fig. 9.—Schubert, Zeitschr. deutsch. geol. Ges., Jahrg., 1901, p. 21, figs. 5, 6.—Millett, Journ. Roy. Micr. Soc., 1904, p. 495.—Bagg, Proc. U. S. Nat. Mus. vol. 34, 1908, p. 160.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 421.—Bagg, Bull. U. S. Geol. Survey, No. 513, 1912, p. 85, pl. 26, fig. 1–6.

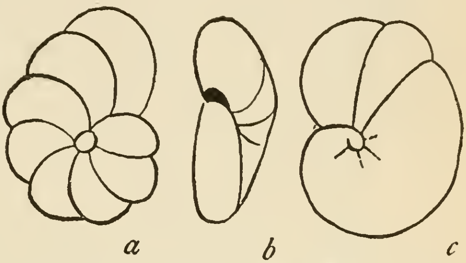

Fig. 50.—Anomalina grosserugosa Gümbel. (Adapted from Gümbel's figure of the type.) *a*, ventral view; *b*, side view; *c*, dorsal view.

Description.—Test nautiloid, dorsal side somewhat concave, ventral side somewhat convex; chambers numerous, in three or more coils, all chambers visible from the dorsal side but only those of the final coil visible on the ventral face, usually seven chambers in the last formed coil; chambers somewhat inflated; sutures depressed, in face view broad; periphery broadly rounded; surface coarsely perforate, usually more so on the ventral side; aperture a narrow curved slit at the base of the chamber.

Diameter 1 mm. or more.

Distribution.—Brady gives two *Challenger* stations in the North Pacific for this species in 345 and 2,050 fathoms. Goës records it under the name *Planorbulina rudis* from two *Albatross* stations D3371 in 770 fathoms and D3375 in 1,201 fathoms off the west coast of tropical America. Bagg records it from numerous stations off the Hawaiian Islands at depths ranging from 367 to 1,544 fathoms. I have had it from numerous *Nero* stations between Guam and Japan and in the *Albatross* material from off Japan at depths ranging from 253 to 1,817 fathoms.

As far as the North Pacific material is concerned this is the most common species of the genus in the region.

ANOMALINA AMMONOIDES (Reuss).

Plate 19, fig. 2.

Rosalina ammonoides Reuss, Geogn. Skizze Böhmen, vol. 2, 1844, p. 214; Verstein böhm. Kreide, vol. 1, 1845–6, p. 36, pl. 8, fig. 53; pl. 13, fig. 66; Haidinger's Naturw. Abhandl., vol. 4, 1850, p. 36, pl. 3, fig. 2.

Planorbulina ammonoides Jones, Geologist, vol. 6, 1863, p. 294, pl. 15, figs. 7, 8.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, figs. 14*a–c*.

Discorbina ammonoides Reuss, Sitz. Akad. Wiss. Wien, vol. 52, 1865, p. 456, No. 5.

Rotalia ammonoides Gümbel, Sitz. bay. Akad. Wiss., 1870, p. 283.

Anomalina ammonoides H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 672, pl. 94, figs. 2, 3.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 228, pl. 45, figs. 20–22.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 378, pl. 13, fig. 35; pl. 14, figs. 36, 37.—Woodward and Thomas, Geol. Nat. Hist. Survey, Minnesota, vol. 3, 1893 (1895), p. 44, pl. D, figs. 28, 29.—Fornasini, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 7, 1898, p. 205, pl., fig. 24.—Chapman, Journ. Roy. Micr. Soc., 1898, p. 4, pl. 1, fig. 5.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 335, pl. 78, fig. 4.—Bagg, Bull. U. S. Geol. Survey, No. 88, 1890, p. 67, pl. 6, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1904, p. 494.—Rhumbler, Zool. Jahrb., Abteil Syst., vol. 24, 1906, p. 67.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 138; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286; Journ. Linn. Soc., Zool., vol. 30, 1910, p. 421.—Bagg, Bull. U. S. Geol. Survey, No. 513, 1912, p. 85, pl. 26, figs. 7–10, *b*.

Description.—Test nearly or quite symmetrical, composed of numerous chambers in three to four coils; umbilici slightly concave, sometimes slightly convex; chambers somewhat inflated; sutures somewhat depressed, about 12 to 16 chambers in the last formed volutions; periphery rounded; wall coarsely perforate, more so on the ventral side; aperture at the middle of the base of the periphery of the chamber.

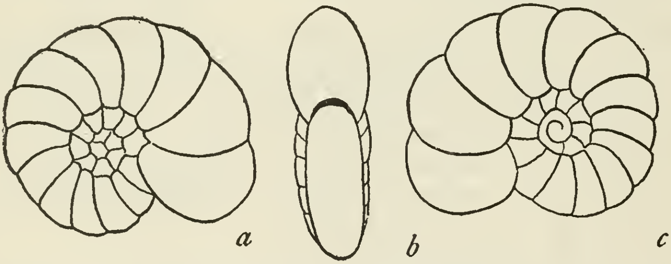

Fig. 51.—Anomalina ammonoides (Reuss). × 90. *a*, dorsal view; *b*, apertural view; *c*, ventral view. (Adapted from Brady.)

Diameter 0.8 to 1.25 mm.

Distribution.—Brady records this species in anchor mud from Hongkong; Bagg, from 12 out of 19 *Albatross* stations off the Hawaiian Islands from which he had material, depths ranging from 104 to 1,544 fathoms, and Rhumbler records one young specimen from Chatham Island.

In the material at my disposal typical specimens have occurred but few times: At *Nero* station 990 in 859 fathoms off Guam and 1254 in 264 fathoms between Guam and Japan, at *Albatross* station H2986 in 271 fathoms off the Hawaiian Islands, and *Tuscarora* station 1 in 206 fathoms, 21° 10′ N.; 158° 04′ W. From the material I have had this species is not as common in the North Pacific as some of the others of the genus.

ANOMALINA POLYMORPHA Costa.

Plate 19, figs. 3, 4.

Anomalina polymorpha Costa, Atti Accad. Pont., vol. 7, 1856, p. 252, pl. 21, figs. 7, 9.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 676, pl. 97, figs. 3–7.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 380, pl. 14, figs. 27, 28, 32–34.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 336, pl. 79, fig. 3.—Chapman, Proc. Roy. Soc. Edinburgh, vol. 23, 1901, p. 392, pl. 1, figs. 4–6; Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 104; Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 138.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 160.—Chapman, Journ. Linn. Soc. Zool., vol. 30, 1910, p. 421.

Description.—Test nautiloid, nearly equally biconvex, ventral side concave, dorsal convex; umbilical region on ventral side depressed; seven to eight chambers in the final coil, in face view broad; periphery broad, angled, some of the chambers with a single large toothlike projection at the periphery; wall coarsely perforate; aperture an elongated arched slit at the base of the chamber.

Diameter up to 1.5 mm.

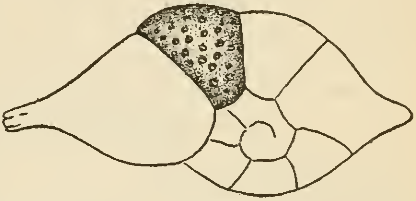

Fig. 52.—Anomalina polymorpha Costa. × 35. after Brady.

Distribution.—Bagg has recorded this species from several *Albatross* stations in the vicinity of the Hawaiian Islands, depths ranging from 305 to 1,274 fathoms. I have had it from numerous stations off the Hawaiian Islands, off Guam, and off Japan, depths ranging from 271 to 2,067 fathoms.

ANOMALINA CORONATA Parker and Jones.

Plate 18, fig. 5.

Anomalina coronata Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 294, pl. 10, figs. 15, 16.—H. B. Brady, Trans. Linn. Soc. London, vol. 24, 1864, p. 469, pl. 48, figs. *a*, *b;* Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 675, pl. 97, figs. 1, 2.—Fornasini, Mem. Acad. Sci. Inst. Bologna, ser. 5, vol. 3, 1893, pl. 2, fig. 17.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 379, pl. 14, figs. 29, 30.—Morton, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 120, pl. 1, fig. 21.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 159.

Planorbulina farcata, var. (*Anomalina*) *coronata* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 383, pl. 14, figs. 7–11.

Planorbulina coronata Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 90, pl. 15, figs. 781–783.

Description.—Test nautiloid, nearly equally biconvex, the dorsal side more convex than the ventral; the umbilical region concave on both sides, broad, in face view nearly as broad as the diameter; peripheral border nearly flattened in the later chambers which increase rapidly in width, about eight chambers in the final coil; wall coarsely perforate. The inner border of the chambers often of clear shell material; aperture a narrow curved slit at the ventral side of the chamber, oblique.

Diameter up to 1.5 mm.

Distribution.—The only North Pacific records for this species seem to be those given by Bagg from four *Albatross* stations off the Hawaiian Islands, D4000, H4566, H4571, H4596, depths ranging from 104 to 572 fathoms. I have failed to find typical specimens of this species.

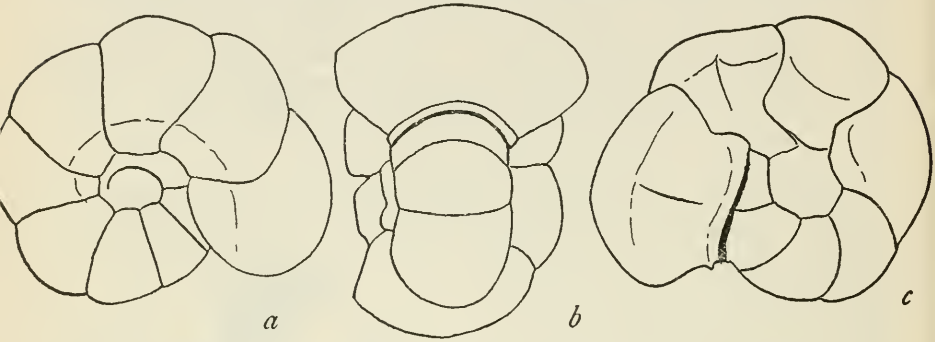

Fig. 53.—Anomalina coronata Parker and Jones. × 40. *a*, dorsal view; *b*, apertural view; *c*, ventral view. (Adapted from Brady.)

Genus CARPENTERIA Gray, 1858.

Carpenteria Gray (type, *C. balaniformis* Gray), Proc. Zool. Soc., London, vol. 26, 1858, p. 269.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 676.

Description.—Test attached, early chambers rotaliform, later ones becoming irregular and inflated, extending upward in an irregular column; chambers few; wall coarsely perforate; aperture in adult specimens usually with a tubular neck.

The species of this genus are apparently most common in the shallow waters of tropical seas. The genus was noted but twice in the North Pacific material examined.

CARPENTERIA MONTICULARIS Carter.

Plate 20, fig. 3.

Carpenteria monticularis Carter, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 211, pl. 13, figs. 9–12.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 677, pl. 99, figs. 1–5.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 439, pl. 21, fig. 12.—Chapman, Journ. Linn. Soc., Zoology, 1900, p. 14, pl. 2, fig. 5; pl. 4, figs. 5, 6.—Millet, Journ. Roy. Micr. Soc., 1904, p. 496.

Description.—Test attached; early chambers coiled, aperture an elongate slit at the inner margin of the chamber, later chambers elongate, irregular, piled up irregularly about a central axis; wall smooth; aperture either a rounded opening at the upper end of the test or with a definite tubular neck.

Distribution.—Brady figures a fine suite of specimens from off Zamboanga, Philippine Islands, from 102 fathoms. He also found it in material dredged by the *Challenger* off Honolulu, Hawaiian Islands, in 40 fathoms. The only material of this species I have seen in the present collection is from *Nero* station 1328 in 871 fathoms off Japan. This is very much like the figures of the young given by Brady.[1]

CARPENTERIA PROTEIFORMIS Goës.

Plate 20, fig. 2; plate 21, fig. 1.

Carpenteria balaniformis, var. *proteiformis* Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 94, pl. 6, figs. 208–214; pl. 7, figs. 215–219.

Carpenteria proteiformis H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 679, pl. 97, figs. 8–14.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 74, pl. 6, figs. 8–17.—Chapman, Journ. Linn. Soc. Zoology, vol. 28, 1900, p. 195, pl. 19, fig. 11.—Millet, Journ. Roy. Micr. Soc., 1904, p. 496, pl. 10, figs. 1–2.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286.

Description.—Test attached, columnar, basal portion usually somewhat spreading and buttressed; early chambers arranged in a coiled manner but covered by the later ones which become much inflated and are built up into an irregular, subcylindrical column of a few chambers; wall coarsely porous; aperture often with a tubular neck.

Length up to 6 mm.

Distribution.—The only specimens from the North Pacific that I have seen came from *Albatross* station D4922, in Colnett or Vincennes Strait in 60 fathoms, bottom temperature 79.2 F. This is essentially a coral-reef species and it adds another to the considerable list of tropical species of foraminifera which have been noted from this and adjoining stations.

Genus RUPERTIA Wallich, 1877.

Rupertia Wallich (type, *R. stabilis* Wallich), Ann Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 502.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 680.

Description.—Test attached, columnar; early chambers coiled, later chambers extending up into a coiled column; wall coarsely punctuate; aperture a narrow curved slit at the inner margin of the chamber.

This genus with the single species here given forms a rather unique modification in the Rotaliidæ.

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[1] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 98, figs. 15, 16.

RUPERTIA STABILIS Wallich.

Plate 21, figs. 2–5.

Rupertia stabilis Wallich, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 501, pl. 20.—Schlumberger, Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 27, pl. 2, fig. 6–8.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 680, pl. 98, figs. 1–12.—Egger, Abh. kön. bay. Akad. Wiss, München, Cl. ii, vol. 18, 1893, p. 439, pl. 21, figs. 8, 9.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 92, pl. 15, fig. 789; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 74.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 336, pl. 79, fig. 4.

Description.—Test attached, with a slightly spreading base, again expanding above into a columnar test, more or less irregular in outline; chambers numerous, arranged in a spiral at the base and then in a spiral manner as the columnar portion is developed; surface smooth but conspicuously punctate; aperture an arched opening near the inner margin of the somewhat concave apertural face; color often yellowish-brown.

Length up to 1.68 mm. or more.

Distribution.—The only record for this species in the North Pacific is that given by Goës from the Eastern Tropical Pacific, *Albatross* D 3419, in 772 fathoms.

Genus PULVINULINA Parker and Jones, 1862.

Pulvinulina Parker and Jones (type *Nautilus repandus* Fichtel and Moll), in Carpenter, Parker, and Jones, Introd. Foram., 1862, p. 201.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 681.

Description.—Test usually rotaliform, dorsal side usually convex, ventral side usually flattened; outline typically circular but in some species elongate; wall finely porous, variously ornamented by costæ, bosses, reticulations, or smooth; aperture typically ventral, extending from near the periphery to the umbilicus.

This genus embraces a large number of species which show a wide range of characters, but they seem to be best distinguished by having the dorsal side convex, ventral side flattened, and the aperture elongate from near the periphery to the umbilicus.

There is much confusion in regard to this generic name, but *Pulvinulina* is kept here as there seems to be some difficulty in regard to earlier names.

PULVINULINA REPANDA (Fichtel and Moll).

Plate 24, fig. 3.

Nautilus repandus Fichtel and Moll, Test. Micr., 1798, p. 35, pl. 3, figs. *a–d*.

Rotalia repanda Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 175, No. 25.

Pulvinulina repanda Parker and Jones, in Carpenter, Parker, and Jones, Introd. Foram., 1862, p. 311.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 206, pl. 3, fig. 61.—Goës, Kongl. Svensk. Vet. Handl., vol. 19, pt. 4, 1882, p. 110, pl. 8, figs. 276–282.—Terrigi, Atti Accad. Pont. Nuovi

Lincei, vol. 35, 1883, p. 198, pl. 3, fig. 42.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 684, pl. 104, figs. 18*a–c*.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 757, pl. 16, fig. 18.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 405, pl. 18, figs. 28–30, 34, 35.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 95, pl. 16, fig. 801.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 328, pl. 72, fig. 8.—Jones and Chapman, in A Monograph of Christmas Island, 1900, p. 228, pl. 20, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1903, p. 496.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 138.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 5.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 87, pl. 24, figs. 5–8.

Description.—Test almost equally biconvex; peripheral margin acute, slightly lobulated, carinate; chambers seven or eight in the last formed whorl; sutures somewhat curved above, nearly radial below, limbate on both surfaces, on the ventral side running into one another and merging at the umbilical area; wall smooth, finely punctate; aperture a slightly arched opening halfway between the umbilicus and the peripheral margin.

Diameter up to 1.5 mm.

Distribution.—Bagg records this species from two *Albatross* stations off the Hawaiian Islands, D4017 in 305 fathoms and H4694 in 865 fathoms. These are the only records for the North Pacific.

PULVINULINA CONCENTRICA Parker and Jones.

Plate 28, fig. 4.

Pulvinulina concentrica (Parker and Jones, MS.) H. B. Brady, Trans. Linn. Soc., London, vol. 24, 1864, p. 470, pl. 48, fig. 14.—Parker and Jones, Philos. Trans., vol. 155, 1865, p. 393.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 686, pl. 105, fig. 1*a–b*.—Uhlig, Jahrb. k. geol. Reichs., vol. 36, 1886, p. 190, pl. 3, figs. 3, 4.—Grzybowski, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej.-Krakowie, vol. 29, 1894, p. 202, pl. 4, fig. 9.—Millett, Journ. Roy. Micr. Soc., 1904, p. 497.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, 1909, No. 21, p. 7, pl. 3, fig. 5.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 287.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, 1910, No. 16, p. 28.

Discorbina vestita Seguenza, Mem. Accad. dei Lincei, ser. 3, vol. 6, 1880, p. 148, pl. 13, fig. 39.

Description.—Test biconvex, oral; chambers comparatively few, five to seven in the last formed coil, carinate; sutures covered by a clear shell material joining with the carinal border and often covering a large portion of the test, both above and below; aperture near the peripheral border on the ventral side.

Diameter up to 2 mm.

Distribution.—Apparently there are no published North Pacific records for this species. I have had specimens from *Albatross* stations D4087 in 44 fathoms and D4922 in 60 fathoms, bottom temperature 79.2° F., both stations off Japan.

PULVINULINA PUNCTULATA (d'Orbigny).

Plate 24, fig. 1.

Rotalia punctulata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 273, No. 25; Modèles, No. 12.

Pulvinulina repanda, var. *punctulata* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 394, pl. 14, figs. 12, 13.

Pulvinulina punctulata Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 20, pl. 3, fig. 82.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 685, pl. 104, fig. 17*a–c*.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 139.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 287.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 86, pl. 25, figs. 6–9.

Description.—Test large, plano-convex, dorsal side somewhat convex, ventral side flattened or even somewhat concave; peripheral margin rounded; chambers usually seven in the last formed whorl; sutures curved, depressed, on the ventral side the chambers running to a point at the umbilicus; wall smooth except at the umbilicus where it is often rugose or granular; aperture a narrow, curved slit at the umbilical end of the chamber.

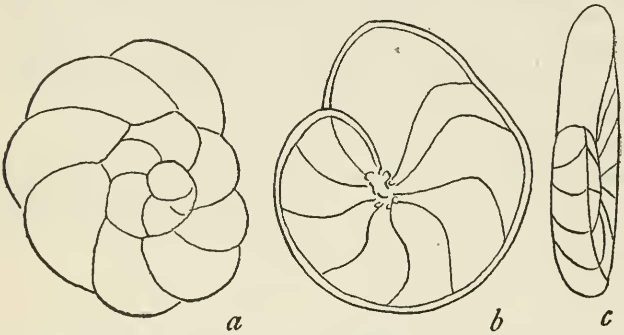


Fig. 54.—Pulvinulina punctulata (d'Orbigny). *a*, dorsal view; *b*, ventral view; *c*, side view. (After Parker and Jones.)

Diameter up to 3 mm.

Distribution.—The only North Pacific record for *Pulvinulina punctulata* is that given by Bagg who records it as rare from *Albatross* D4017 in 305 fathoms, off the Hawaiian Islands. I have failed to find specimens of this species in the material which I have examined from other stations.

PULVINULINA CONCAMERATA (Montagu).

Plate 25, fig. 1.

Serpula concamerata Montagu, Test. Brit., Suppl., 1808, p. 160.

Rotalina concamerata Williamson, Rec. Foram. Great Britain, 1858, p. 52, pl. 4, figs. 102, 103.

Pulvinulina repanda Carpenter, Parker and Jones, Introd. Foram., Appendix, 1862, p. 311.

Pulvinulina repanda, var. *concamerata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 685, pl. 104, fig. 19*a–c*.

Description.—Test biconvex, the sides about equally so; chambers six to eight in the last-formed coil, distinct; sutures on the ventral side simple and depressed, dorsally limbate; peripheral margin carinate, dorsally with a raised margin confluent with that of the sutures; surface smooth below, above with numerous rounded bosses scattered thickly over the area between the raised sutural lines.

Diameter up to 2 mm.

Distribution.—This species has apparently not previously been recorded from the North Pacific. It occurred in some considerable numbers at *Albatross* station D4807 in 44 fathoms off Japan.

PULVINULINA AURICULA (Fichtel and Moll).

Plate 22, fig. 1.

Nautilus auricula, var. *a*, Fichtel and Moll, Test. Micr., 1803, p. 108, pl. 20, figs. *a-c*.

Pulvinulina auricula Parker and Jones, Philos. Trans., vol. 155, 1865, p. 393.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 173, pl. 12, fig. 143.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 206, pl. 3, fig. 58.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 109, pl. 8, figs. 273-275.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 688, pl. 106, figs. 5*a-c*.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 105.

Description.—Test elongate oval, biconvex, the dorsal side slightly convex, the ventral side more strongly so; peripheral margin in later chambers acute, in the early ones rounded; chambers six or seven in the last-formed whorl, rapidly increasing in size and length, the last-formed chamber especially on the ventral side occupying the larger part of the whole area of the test; sutures but very slightly depressed, distinct; wall smooth, thin and translucent, finely perforate; aperture a narrow slit near the umbilicate end of the chamber.

Diameter up to 1 mm.

Distribution.—Brady in the *Challenger* Report gives the only North Pacific record for this species in 95 fathoms off the Philippines. From the available records this species does not extend to very great depths, which may account for the fact that I have not found it in the North Pacific material which I have examined.

PULVINULINA OBLONGA (Williamson), var. SCABRA H. B. Brady.

Plate 27, fig. 5.

Pulvinulina oblonga (Williamson), var. *scabra* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 689, pl. 106, fig. 8*a-c*.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 229, pl. 46, fig. 5.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 6, pl. 3, figs. 3, 4; vol. 54, No. 16, 1910, p. 27.

Description.—Test biconvex, dorsal side nearly flattened, ventral side more convex; peripheral margin acute, carinate; chambers seven or eight in the final whorl, rapidly increasing in size and length as added, on the ventral side the last formed chamber in the adult taking up at least one-half the area of the test; sutures slightly depressed, limbate above and below, wall rugose or granular on the dorsal side, smooth below.

Diameter about 0.5 mm.

Distribution.—The only published record for this seems to be that of Brady from the *Challenger* station off the Philippines in 95 fathoms. I have questionable specimens from *Nero* station 1073 in 1,208 fathoms.

PULVINULINA HAUERII (d'Orbigny).

Plate 22, fig. 4.

Rotalina hauerii D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 151, pl. 7, figs. 22–24.

Pulvinulina hauerii PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 393.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 690, pl. 106, figs. 6, 7.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 414, pl. 17, figs. 29–31.—WOODWARD and THOMAS, Geol. Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 44, pl. E, fig. 34.—CHAPMAN, Journ. Roy. Micr. Soc., 1898, p. 5, pl. 1, fig. 7.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 21, 1899, p. 154, pl. 18, figs. 4–6.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 498.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, 1909, No. 21, p. 7, pl. 3, fig. 6.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 423.

Description.—Test biconvex, somewhat elongate, twice as long as wide, composed of few chambers in the last-formed coil; chambers rotund; sutures deeply depressed; wall smooth except for the rather coarse punctæ; aperture on the ventral border of the margin of the chamber.

Length about 1 mm.

Distribution.—Apparently this species has not previously been recorded from the North Pacific. I have material from *Albatross* station D4966 in 290 fathoms, bottom temperature 44.1° F., off Japan.

This species may be distinguished from *Pulvinulina auricula* by its much more rounded contour.

PULVINULINA MENARDII (d'Orbigny).

Plate 22, fig.2.

Rotalia menardii D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 273, No. 26; Modèles, No. 10.

Pulvinulina menardii OWEN, Journ. Linn. Soc. London (Zool.), vol. 9, 1867, p. 148, pl. 5, fig. 6.—THOMSON, Proc. Roy. Soc. London, vol. 23, 1875, p. 37, pl. 3, figs. 1, 2.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 112, pl. 8, figs. 289–295.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 80; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 690, pl. 103, figs. 1,2.—MALAGOLI, Boll. Soc. Geol. Italia, vol. 6, 1887, p. 523, pl. 13, fig. 10.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., London, vol. 12, 1888, p. 228, pl. 46, fig. 3.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 19, 1893, p. 411, pl. 17, figs. 1–3, 7–12.—Woodward and Thomas, Geol. Nat. Hist. Survey Minnesota, vol. 3, 1893, p. 45, pl. E, fig. 33.—Burrows and Holland, Proc. Geol. Ass., vol. 15, 1897, p. 48, pl. 2, fig. 22.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 73, fig. 3.—Rhumbler, in Brandt, Nordisches Plankton, Heft. 14, 1900, p. 14, figs. 6–8; Zeitschr. für allgem. Phys., vol. 2, 1902, p. 234, fig. 67.—Fornasini, Mem. Accad. Sci. Inst. Bologna, ser. 5*a*, vol. 10, 1902, p. 58, fig. 55.—Millett, Journ. Roy. Micr. Soc., 1904, p. 499.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 162.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.

Description.—Test plano-convex, compressed, dorsal side slightly convex, ventral side flat or somewhat concave, umbilicate; peripheral margin thin, slightly lobulated, carinate; chambers usually six in the last-formed coil; sutures somewhat depressed, especially below, on the dorsal side limbate and curved, ventrally simply depressed, straight, in a radial position; wall usually smooth and punctate but sometimes slightly granular; aperture a rather well-developed opening at the umbilical end of the chamber, with a projecting valvular lip.

Diameter up to 1.27 mm.

Distribution.—This species of world-wide distribution is not uncommon in the North Pacific. Goës records its being taken in a pelagic condition. Picaglia records it at three stations of the *Vettor Pisani* just north of the Equator. Bagg records it at 18 out of the 19 *Albatross* stations from which he had material in the vicinity of the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms. I have records of its occurrence at a hundred or more *Albatross, Alert, Nero,* and *Tuscarora* stations in the area, and this could have been multiplied several times but it was thought not worth while to record further. It is common in the North Pacific wherever conditions of depth and temperature are right for the formation of *Globigerina* ooze.

PULVINULINA MENARDII (d'Orbigny), var. FIMBRIATA H. B. Brady.

Pulvinulina menardii d'Orbigny, var. *fimbriata* H. B. Brady, Rep. Voy. *Challenger*, vol. 9, 1884, p. 691, pl. 103, fig. 3*a*, *b*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 412, pl. 17, fig. 19.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 73, fig. 4.—Rhumbler, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 16, fig. 9.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 162.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.

Description.—Variety differing from the typical in the smaller size and spinose character of the peripheral keel.

Distribution.—Bagg records this variety from three *Albatross* stations in the vicinity of the Hawaiian Islands, depths from 384 to 1,307 fathoms. I have seen a few rather poorly representative specimens from this same region, but there does not appear to be as good a development of the variety as occurs in the Gulf of Mexico for example.

PULVINULINA TUMIDA H. B. Brady.

Plate 22, fig. 3.

Pulvinulina menardii d'Orbigny, var. *tumida* H. B. Brady, Geog. Mag., vol. 4, 1877 p. 294; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 80.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 163.

Pulvinulina tumida H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 692, pl. 103, figs. 4–6.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 414, pl. 17, figs. 4–6, 35–37, 44.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 73, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1904, p. 499.—Cushman, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 31.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 422.

Description.—Test biconvex, oval, dorsal surface convex especially in the early portion, ventral side less convex, umbilicate; peripheral margin rounded, becoming more acute in the later formed portion with a rounded carina; chambers fairly numerous, about six in the last-formed whorl; sutures curved, depressed on the ventral side; wall of the early portion of the test granular, later chambers becoming progressively smoother; aperture an arched opening near the umbilical end of the margin of the chamber, often with a slight valvular projection above.

Diameter up to 1.25 mm.

Distribution.—Brady records *Pulvinulina tumida* from two *Challenger* stations in the North Pacific at depths of 500 and 1,850 fathoms. Picaglia records it from three stations of the *Vettor Pisani* in the same area. Bagg records it from 13 out of the 19 stations in the vicinity of the Hawaiian Islands from which he had material, depths ranging from 104 to 1,544 fathoms. I have had specimens from several stations off the Hawaiian Islands at depths varying from 1,265 to 2,615 fathoms, from off the Galapagos Islands D2806 in 1,379 fathoms and from a great number of *Nero* stations, especially between Guam and Yokohama. It seems to be common where *Globigerina* ooze conditions obtain.

PULVINULINA CANARIENSIS (d'Orbigny).

Plate 23, fig. 1.

Rotalina canariensis d'Orbigny, in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 130, pl. 1, figs. 34–36.

Pulvinulina repanda, var. *menardii*, subvar. *canariensis* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 395, pl. 16, figs. 47–49.

Pulvinulina canariensis Owen, Journ. Linn. Soc. London, vol. 9, Zool., 1867, p. 148, pl. 5, fig. 21.—H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 80.—Terrigi, Atti Acad. Pont. Nuovi Lincei, vol. 33, 1880, p. 207, pl. 3, figs. 59, 60.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 692, pl. 103, figs. 8–10.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 413, pl. 17, figs. 20–22.—Rhumbler, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 16, fig. 10.—Millett, Journ. Roy. Micr. Soc., 1904, p. 500.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 105.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 160.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.

Description.—Test biconvex, dorsal surface somewhat umbonate, ventral low and broadly rounded, umbilicate; peripheral margin acute, conspicuously lobulated with rounded angles, slightly carinate; chambers comparatively few, usually five in the last formed whorl; sutures distinct above, slightly depressed, below much depressed; wall of earlier portion spinosely granular, later chambers becoming progressively smooth, the last formed chamber often very smooth; aperture a narrow curved slit extending from the umbilicus well toward the peripheral margin.

Diameter up to 1.25 mm.

Distribution.—In the *Challenger* Report Brady states that this species is much less common in the North Pacific and Indian Ocean than in the other oceans. As far as the North Pacific is concerned this is apparently due to lack of material at his disposal. He recorded it from but one North Pacific station off Japan in 345 fathoms. Bagg records it from 15 out of 19 *Albatross* stations from which he had material off the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms. I have had specimens from *Albatross* H2923 in 392 fathoms off the Hawaiian Islands and D2806 in 1,379 fathoms off the Galapagos Islands. Between Guam and Japan it has occurred at numerous *Nero* stations, depths ranging from 264 to 1,990 fathoms.

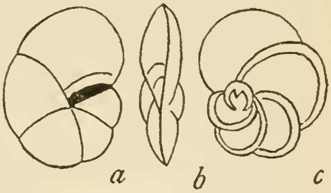


FIG. 55.—PULVINULINA CANARIENSIS (D'ORBIGNY). *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW. (AFTER D'ORBIGNY'S TYPE FIGURE.)

Brady also records the species from one surface station in the North Pacific.

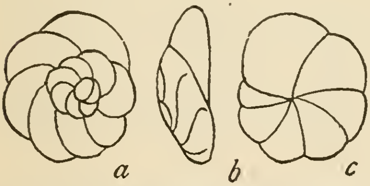


FIG. 56.—PULVINULINA PATAGONICA (D'ORBIGNY). *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER D'ORBIGNY'S TYPE FIGURE.)

PULVINULINA PATAGONICA (d'Orbigny).

Rotalina patagonica D'ORBIGNY, Voy Amér. Mérid., 1839, "Foraminifères," p. 36, pl. 2, figs. 6–8.

Pulvinulina patagonica H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 693, pl. 103, fig. 7*a–c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 413, pl. 17, figs. 16–18.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 13, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 500.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 162.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 422.

Description.—Test small, biconvex, dorsal side more convex than the ventral; peripheral margin rounded, slightly lobulated; chambers few, usually five in the last formed whorl; sutures much curved, depressed; wall granular roughened; aperture a narrow arched slit extending from the umbilicus well toward the peripheral margin.

Diameter 0.25–0.40 mm.

Distribution.—Brady records *Pulvinulina patagonica* from four *Challenger* stations in the North Pacific, the depths ranging from 500 to 2,900 fathoms. Bagg records it from two *Albatross* stations in the vicinity of the Hawaiian Islands H4502 in 1,342 fathoms and H4566 in 572 fathoms.

From the material I have had this species seems to be rather common in the North Pacific. It was frequent at many *Nero* stations between Guam and Yokohama depths ranging from 518 to 2,048 fathoms.

This species somewhat closely resembles *P. canariensis* but may be easily distinguished by the periphery.

PULVINULINA CRASSA (d'Orbigny).

Plate 27, fig. 1.

Rotalina crassa d'Orbigny, Mém. Soc. Géol. France, vol. 4, 1840, p. 32, pl. 3, figs. 7, 8.

Pulvinulina crassa Owen, Journ. Linn. Soc. Zool. London, vol. 9, 1867, p. 148; pl. 5, fig. 8(?), 9.—H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 80; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 694, pl. 103, figs. 11, 12.—Terrigi, Mem. Com. Geol. Ital., vol. 4, 1891, p. 108, pl. 4, fig. 13.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 416, pl. 18, figs. 7–12.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 74, fig. 1.—Rhumbler, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 17, figs. 12, 14, 15.—Millett, Journ. Roy. Micr. Soc., 1904, p. 500.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 105.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 161.—Chapman, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.

Description.—Test subconical, the dorsal face flat, ventral face convexly rounded, umbilicate; peripheral margin rounded, lobulated, not carinate; chambers comparatively few, usually but four in the last formed whorl, sutures curved; surface granular or subspinose; aperture an arched opening widest at the umbilical end of the chamber and extending nearly to the periphery.

Diameter 0.50–0.60 mm.

Distribution.—Brady records *Pulvinulina crassa* from a single *Challenger* station in the North Pacific in 2,250 fathoms. Bagg records it from six *Albatross* stations in the vicinity of the Hawaiian Islands at depths ranging from 384 to 1,544 fathoms. I have failed to find any specimens which I could refer to this species.

PULVINULINA TRUNCATULINOIDES (d'Orbigny).

Plate 23, fig. 4.

Rotalina truncatulinoides D'ORBIGNY, in Barker, Webb, and Berthelot, Hist. Nat. Îsles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 132, pl. 2, figs. 25–27.

Pulvinulina truncatulinoides PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 398, pl. 16, figs. 41–43.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 17, fig. 16.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 105; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 423.

Rotalina micheliniana D'ORBIGNY, Mém. Soc. Géol. France, vol. 4, 1840, p. 31, pl. 3, figs. 1–3.

Discorbina micheliniana REUSS, Sitz. Akad. Wiss. Wien, vol. 52, 1865, p. 455, No. 1.

Pulvinulina repanda, var. *menardii*, subvar. *micheliniana* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 396, pl. 14, fig. 16, pl. 16, figs. 41–43.

Pulvinulina micheliniana OWEN, Journ. Linn. Soc. London, Zool., vol. 9, 1867, p. 148, pl. 5, fig. 17.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 114, pl. 8, figs. 296–298.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 694, pl. 104, figs. 1, 2.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 229, pl. 46, figs. 9, 10.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 416, pl. 18, figs. 1–6.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 500.

Pulvinulina micheliniana FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 330, pl. 74, fig. 2.

Description.—Test subconical, the dorsal surface either flat or more often slightly concave, ventral surface forming a truncate cone, umbilicate; peripheral margin angular, bluntly rounded, often slightly carinate; chambers comparatively few, five or six in the last formed whorl, sutures nearly radial; dorsal surface nearly smooth, punctate or slightly granular, ventral surface very often decidedly granular; aperture a long narrow opening extending from the umbilicus nearly to the peripheral margin.

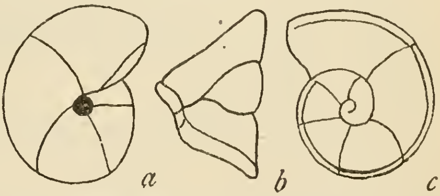


FIG. 57.—PULVINULINA TRUNCATULINOIDES (D'ORBIGNY). *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW (AFTER D'ORBIGNY).

Diameter 0.60–1 mm.

Distribution.—This is one of the most common of the species of the North Pacific, especially at depths which are favorable to the accumulation of *Globigerina* ooze. Brady and Goës record it as pelagic in the North Pacific and Brady records it from five *Challenger* stations with depths ranging from 345 to 2,950 fathoms. Picaglia records it from a single station of the *Vettor Pisani* in the North Pacific and Bagg records its occurrence at 17 out of the 19 *Albatross* stations off the Hawaiian Islands from which he had material, depths ranging from 104 to 1,544 fathoms.

I have had material from various parts of the North Pacific from *Albatross*, *Nero*, *Tuscarora*, and *Alert* stations ranging in depth from

264 to 2,615 fathoms. Between Guam and Yokohama at the *Nero* stations where a record was kept it was present at nearly every station.

The specific name *truncatulinoides* antedates *micheliniana* and so must be adopted, as has been done by some writers. This is one of the characteristic constituents of the *Globigerina* ooze in the North Pacific as elsewhere.

PULVINULINA UMBONATA (Reuss).

Plate 27, fig. 2.

Rotalina umbonata Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 75, pl. 5, fig. 35*a–c*.

Pulvinulina umbonata Reuss, Deutsch. Akad. Wiss. Wien, vol. 25, 1866, p. 206.—Hantken, Mitth. Jahrb. ung. geol. Anstalt., vol. 4, 1875, p. 77, pl. 9, fig. 8*a–c*.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 200, pl. 4, figs. 45, 46.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 695, pl. 105, fig. 2*a–c*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 410, pl. 18, figs. 19–21.—Flint, Rep. U. S. Nat. Mus. 1897 (1899), p. 330, pl. 74, fig. 4.

Description.—Test small, sides unequally convex, the dorsal side much less convex than the ventral; peripheral margin acute; chambers five or six in the last-formed coil; sutures nearly straight, radial, distinct but not depressed; wall smooth, finely punctate; aperture a narrow slit extending from the umbilicus to the peripheral margin

Diameter about 0.50 to 0.75 mm.

Distribution.—Brady records this species from three *Challenger* stations in the North Pacific at depths ranging from 345 to 3,125 fathoms. Flint records it from *Albatross* station D3080 in 93 fathoms off the coast of Oregon.

I have seen it only from a *Nero* station, 1207 in 665 fathoms off the coast of Japan.

PULVINULINA EXIGUA H. B. Brady.

Plate 23, fig. 5.

Pulvinulina exigua H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 696, pl. 103, figs. 13, 14.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 75.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 28.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 422.

Description.—Test small, almost equally convex on the two sides; peripheral margin bluntly rounded, often lobulated; chambers comparatively few, five or six in the last formed whorl; sutures above as well as the border of the whorl in the early portion marked by clear shell material, on the ventral side depressed and not so marked; wall finely punctate; aperture a narrow slit running from the peripheral margin to the umbilicus.

Diameter 0.3 to 0.5 mm.

Distribution.—Brady records *Pulvinulina exigua* from five *Challenger* stations in the North Pacific depths ranging from 15 to 2,300 fathoms. Goës records it from a single *Albatross* station D3433 in 1,218 fathoms, rare. I have had it from *Nero* station 10 between the Hawaiian and Midway Islands and from numerous *Nero* stations between Guam and Yokohama ranging in depth from 859 fathoms off Guam to 2,098 fathoms. As far as noted, it has usually occurred as few specimens at any one station.

PULVINULINA PAUPERATA Parker and Jones.

Plate 23, figs. 2, 3.

Pulvinulina repanda, var. *menardii*, subvar. *pauperata* Parker and Jones, Philos. Trans., vol. 155, 1865, p. 395, pl. 16, figs. 50, 51.

Pulvinulina pauperata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 696, pl. 104, figs. 3–11.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 412, pl. 17, figs. 32, 34.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 77.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 330, pl. 74, fig. 3.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 423.

Description.—Test much flattened, planospiral; peripheral margin extended into a broad, flat, thin, transparent carina, occasionally somewhat thickened at the margin; chambers numerous, ten to fifteen in the last formed coil, all visible from both sides of the test; sutures depressed; chambers inflated; aperture a small opening near the peripheral margin of the test.

Diameter up to 3 mm.

Distribution.—This rather unique species seems to be rather well distributed in the North Pacific but does not appear to be common at any particular stations. Brady records it from one *Challenger* station in 1,850 fathoms. Goës notes its occurrence at four *Albatross* stations in the western Tropical Pacific at depths ranging from 770 to 1,201 fathoms. Picaglia records it from a single station just north of the equator. Flint noted its occurrence at *Nero* station 760 in 1,560 fathoms between Midway Islands and Guam. I have had specimens from off the Galapagos Islands *Albatross* D2806 in 1,379 fathoms and from a large number of *Nero* stations from Guam to Yokohama, depths ranging from 1,029 to 2,278 fathoms. This species varies considerably in the width of the marginal wing-like carina. In its remote chambers also it differs from others of the genus.

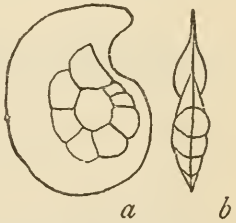


Fig. 58.—Pulvinulina pauperata Parker and Jones. *a*, side view; *b*, view from periphery. (After type figure by Parker and Jones.)

PULVINULINA SCHREIBERSII (d'Orbigny).

Rotalina schreibersii D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 154, pl. 8, figs. 4–6.

Pulvinulina schreibersii PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 393.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 697, pl. 115, fig. 1*a–c*.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., London, vol. 12, 1888, p. 228, pl. 46, fig. 4.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 409, pl. 18, figs. 31–33, 67–69.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 501.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 106.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 8, pl. 3, fig. 8.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 289.

Truncatulina schreibersii SEGUENZA, Atti Accad. Lincei, ser. 3, vol. 6, 1879, p. 149, etc.

Description.—Test subconical, dorsal side elevated, apex broadly rounded, ventral side slightly convex; peripheral margin bluntly rounded; chambers numerous, about seven to nine in the last-formed whorl; sutures but slightly depressed above, curved, below more depressed, the umbilical ends filled with secondary material to form a stellate mass; wall finely punctate, smooth; aperture a narrow opening extending from near the peripheral margin wholly or partially to the umbilical end of the chamber.

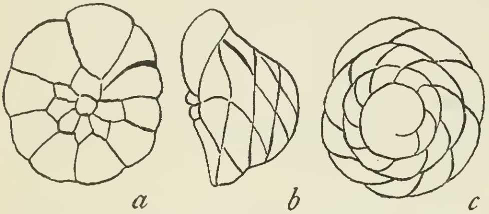


FIG. 59.—PULVINULINA SCHREIBERSII (D'ORBIGNY). *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW. (AFTER TYPE FIGURES BY D'ORBIGNY.)

Diameter up to 1.30 mm.

Distribution.—The two stations in the vicinity of the Hawaiian Islands recorded by Bagg seem to be the only records for this species in the North Pacific. They are *Albatross* H4476 in 438 fathoms and H4566 in 572 fathoms.

PULVINULINA PROCERA H. B. Brady.

Plate 24, fig. 2; plate 25, fig. 2.

Pulvinulina procera H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 66; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 698, pl. 105, fig. 7*a–c*.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.

Description.—"Test trochoid, forming an elevated cone with rounded apex and flat or truncate inferior face; composed of numerous convolutions, the last of which consists of about six segments; segmentation very oblique, indistinct on the superior face, especially near the center; sutures and periphery more or less limbate on the inferior side; aperture an arched slit at the margin of the final segment, near the umbilicus.

"Diameter, 1-22 inch (1.1 mm.)."

Distribution.—The only definitely recorded station for this species in the North Pacific seems to be that given by Bagg, *Albatross* H4508 in 495 fathoms off the Hawaiian Islands. I have found the species in the material which I have examined only from one station, *Albatross* D4874, in 66 fathoms off Japan. This is the station at which numerous other tropical species occur, such as *Truncatulina præcincta* and *T. margaritifera.*

PULVINULINA KARSTENI (Reuss).

Plate 26, fig. 1.

Rotalia karsteni REUSS, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 273, pl. 9, fig. 6.

Pulvinulina karsteni H. B. BRADY, Trans. Linn. Soc., vol. 24, 1864, p. 470, pl. 48, fig. 15; Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 436, pl. 21, fig. 11*a–c;* Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 698, pl. 105, fig. 8, 9.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 758, pl. 16, fig. 21*a–c.*—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 330, pl. 74, fig. 5.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 7, pl. 3, fig. 7.

Pulvinulina repanda, var. *karsteni* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 396, pl. 14, figs. 14, 15, 17; pl. 16, figs. 38–40.

Description.—Test almost equally biconvex, the dorsal side slightly more conical, the ventral side rather more broadly rounded; peripheral margin carinate, bluntly rounded; chambers numerous, about five to seven in the last formed whorl; sutures curved, slightly if at all depressed above, below more compressed; wall finely punctate; aperture a narrow slit extending from the umbilical end of the chamber to the peripheral margin.

Diameter 0.3 to 0.6 mm.

Distribution.—Apparently this species has not previously been recorded from the North Pacific. I have material from but two stations in western Pacific *Albatross* D4822 in 130 fathoms and *Nero* 1065 in 1,321 fathoms.

PULVINULINA ELEGANS (d'Orbigny).

Plate 26, fig. 3.

Rotalia (*Turbinulina*) *elegans* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 276, No. 54.

Pulvinulina elegans JONES and PARKER, Geologist, vol. 7, 1864, p. 88.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 174, pl. 12, fig. 142.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 699, pl. 105, figs. 4–6.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 228, pl. 46, fig. 2.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 489, pl. 11, fig. 30–32.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 410, pl. 18, figs. 37–39.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 3, 1893, p. 435, pl. 2, fig. 18.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 97, pl. 16, fig. 808; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 76.—CHAPMAN, Journ. Roy. Micr. Soc., 1898, p. 6, pl. 1, fig. 8.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 1.—MILLETT, Journ. Roy.

Micr. Soc., 1904, p. 501.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 139.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 161.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 288; Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 421.—Bagg, Bull. U. S. Geol. Surv., No. 513, 1912, p. 86, pl. 26, figs. 11–15, c.

Description.—Test comparatively large, nearly equally convex on the two sides; peripheral margin bluntly rounded; chambers numerous, usually eight or nine in the last-formed whorl; sutures slightly if at all depressed; walls thickened and beautifully marked by clear shell material, the chambers each with an ornamentation of an irregular pattern of dots, lines, and irregular areas of clear shell material on a white opaque background; aperture a narrow opening at the umbilical end of the margin of the chamber with an occasional secondary slit near the peripheral margin.

Diameter up to 1.5 mm.

Distribution.—*Pulvinulina elegans* seems to be common in the North Pacific in spite of Brady's note that it is less common than elsewhere. This is again probably due to lack of material. Goës records it from 10 *Albatross* stations in the eastern Tropical Pacific at depths ranging from 660 to 1,832 fathoms. Flint records it from one *Albatross* station D2805 in Panama Bay, depth 51 fathoms. From about the Hawaiian Islands Bagg records it from nine *Albatross* stations, the depths ranging from 367 to 1,544 fathoms. I have had material from several *Albatross* stations off the Hawaiian Islands, depths ranging from 323 to 1,783 fathoms. It occurred at *Albatross* station D2806 off the Galapagos Islands in 1,379 fathoms. In the *Nero* material it has occurred frequently between Guam and Yokohama, the depths ranging from 891 fathoms off Guam to 2,189 fathoms.

PULVINULINA PARTSCHIANA (d'Orbigny).

Rotalina partschiana d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 153, pl. 7, figs. 28–30, pl. 8, figs. 1–3.

Pulvinulina partschiana Reuss, Sitz. Akad. Wiss. Wien, vol. 62, 1870, p. 36.—von Schlicht, Foram. Pietzpuhl, 1870, pl. 20, figs. 23–25, 29–31.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 699, pl. 105, fig. 3*a–c*, woodcut, fig. 21.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, p. 410, pl. 17, fig. 43; pl. 18, figs. 25–27.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 3.—Millett, Journ. Roy. Micr. Soc., 1904, p. 502.—Bagg, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 162.—Chapman, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 287.

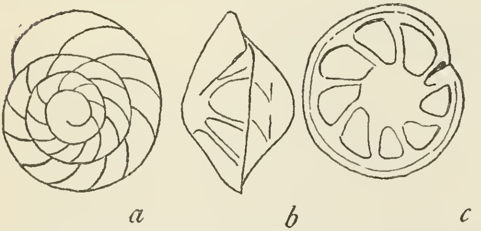


Fig. 60.—Pulvinulina partschiana (d'Orbigny). *a*, dorsal view; *b*, side view; *c*, ventral view. (After d'Orbigny's type figure.)

Placentula partschiana Berthelin, Bull. Soc. Geol. France, ser. 3, vol. 11, 1882, p. 16.

Description.—Test small, nearly equally convex, dorsal side slightly more conical, ventral side broadly rounded; peripheral margin acute, carinate; chambers numerous, nine or ten in the last-formed coil, short; sutures strongly curved, slightly depressed above, strongly limbate below, the umbilical ends uniting to form an umbonate mass; wall punctate without variegated markings; aperture a short somewhat arched opening on the ventral side toward the peripheral margin.

Diameter 0.40–0.75 mm.

Distribution.—Bagg records this species from a single *Albatross* station H4568 in 1,274 fathoms off the Hawaiian Islands. I have had it from several *Albatross* stations also off the Hawaiian Islands, depths ranging from 266 to 618 fathoms.

PULVINULINA FAVUS H. B. Brady.

Pulvinulina favus H. B. Brady, Geol. Mag., dec. 2, vol. 4, 1877, p. 294; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 701, pl. 104, figs. 12–16.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 417, pl. 18, figs. 13–15.

Description.—Test biconvex, lenticular, the two faces nearly equally convex; peripheral margin subacute, slightly rounded; chambers numerous, about 12 in the last formed whorl, elongate; sutures oblique, entirely hidden by the surface ornamentation which is composed of a raised reticulated network covering the entire test except that portion of the periphery about the aperture which is usually just ventral to the peripheral margin, slightly oblique, oval.

Diameter 0.75 to 1.25 mm.

Distribution.—This species has previously been noted from but one North Pacific station; Brady recording it from *Challenger* station 224 in 1,850 fathoms in lat. 7° 45′ N.

I have found it to be very common, especially in the region between Guam and Yokohama, where it was recorded at about 50 stations, after which recording was stopped, as it occurred at nearly every station. The recorded stations range in depth from 847 to 2,250 fathoms, the average depth being about 1,800 fathoms with but one station less than 1,250 fathoms. It also occurred eastward at *Nero* station 124 in 1,726 fathoms and at *Tuscarora* station 221° 07′ N; 158° 14′ W. in 1,468 fathoms.

It is a striking species with its peculiar type of ornamentation. Apparently it is most common at considerable depths, from 1,500 to 2,000 fathoms, and is widely distributed in the western portion of the Pacific, coming eastward to the central portion.

PULVINULINA GILBERTI Bagg.

Pulvinulina gilberti BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 161, pl. 5, figs. 11–15.

Description.—"The test is highly vaulted upon the interior side, with deeply sunken septa, which extend from the margin to the umbilicus in an almost straight line, as in *Pulvinulina canariensis* d'Orbigny, which this species somewhat resembles. The segments are, however, more compactly built, and the aperture, a neatly shaped arch, lies midway between the periphery and the umbilicus upon the inferior surface. The superior surface instead of being vaulted as in *P. canariensis,* is almost complanate and the periphery is almost keeled, being quite sharp and distinct, although somewhat lobulated on the last two chambers of the ultimate whorl. There are five segments visible in the last convolution, and they are equally distinct upon both surfaces.

"The shell is very minute and firmly built. It has a slight resemblance to *Truncatulina dutemplei* (d'Orbigny), but the margin is sharp and more angular in the present form, and the septal lines upon the inferior surface are much more depressed and the chambers more inflated. It is somewhat doubtful whether the present form should be considered a distinct species or only a variety of *Pulvinulina menardii,* which it resembles. It is much smaller than *P. menardii,* much more vaulted upon the inferior surface, and a little more closely involute. The septal depressions also are strong, deeply sunken on the lower side and extend straight to the center. Upon the superior side they are strongly curved as in *P. menardii.* There are five of these chambers in the final convolution. The ultimate chamber is largest, and in its outline reminds one of the auriculate type of *Pulvinulinae,* but it is not so extended from the whorl. It is not a young form of *P. menardii.*"

Distribution.—"Present and rather common at [*Albatross*] station H4555," in 1,398 fathoms, off the Hawaiian Islands.

In the figures, which are not very distinct, this species seems to me to very greatly resemble *P. menardii.* An examination of the specimens also seems to confirm this. Just what disposal should be made of the form there is not sufficiently well marked material to decide. The descriptive notes are from Bagg.

Genus ROTALIA Lamarck, 1804.

Nautilus LINNÆUS (part) Syst. Nat., ed. 12, 1767, p. 1162.

Rotalia LAMARCK, (type, *Nautilus beccarii* Linnæus), Ann. Mus., vol. 5, 1804, p. 184.—D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 275.—H. B. BRADY, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 702.

Description.—Test free, composed of numerous chambers arranged in a flattened spire, the two sides biconvex or varying from flat above and convex below to convex above and flattened below; all chambers visible from the dorsal side, only those of the last-formed coil visible from below; the umbilical region as usually filled with clear shell material; surface variously ornamented with raised bosses or costæ or smooth and unornamented; aperture a single curved opening toward the periphery on the ventral side of the chamber.

There are several species of this genus presenting a considerable range of form and ornamentation. Certain of the species are abundant in shallow water of the temperate or even subarctic zones, while others are characteristic of shallow waters of the tropics. The largest and most ornate species are these latter.

ROTALIA BECCARII (Linnæus).

Plate 30, fig. 3.

"Cornu Hammonis" PLANCUS, Conch. Min., 1739, p. 8, pl. 1, fig. 1 A–C.

"Ammonia unita" GAULTIERI, Index Test., 1742, pl. 19, figs. H, I.

Nautilus beccarii LINNÆUS, Syst. Nat., ed. 12, 1767, p. 1162; ed. 13 (Gmelin's), 1788, p. 3370, No. 4.

"Hammoniæ conico-tuberculatæ" SOLDANI, Testaceographia, vol. 1, pt. 1, 1789, p. 56, pl. 35, fig. P.

Rotalia (*Turbinulina*) *beccarii* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 275, No. 40; Modèles, No. 74.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 30, pl. 3, fig. 83.

Rotalia beccarii PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 388, pl. 16, figs. 29, 30.—H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 303, pl. 12, figs. 8*a–c*.—SCHWAGER, Boll. com. geol. Ital., vol. 8, 1877, p. 26, pl., fig. 43.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 208, pl. 3, fig. 62, pl. 4, fig. 63–66.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 704, pl. 107, figs. 2, 3.—WRIGHT, Proc. Belfast Nat. Field Club, 1884–85, App. 9, 1886, p. 332, pl. 27, fig. 15.—MALAGOLI, Boll. Soc. geol. Ital., vol. 6, 1887, p. 523, pl. 13, fig. 11.—TERRIGI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 119, pl. 9, figs. 4, 5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 420, pl. 19, figs. 25–27.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 99, pl. 16, fig. 811.—RHUMBLER, Zeitschr. Wiss. Zool., vol. 57, 1894, p. 574, pl. 22, fig. 41.—LISTER, Philos. Trans., vol. 186, 1895, p. 436, pl. 8, figs. 38–40.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, 1898, p. 259, figs.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 2.—WRIGHT, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 22.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 10, 1902, p. 59, figs. 56–58.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 502.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 139.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 31.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 10, pl. 4, fig. 6; vol. 54, No. 16, 1910, p. 28.

Description.—Test with the sides about equally biconvex; chambers numerous, from 8–12 in the last formed whorl; peripheral margin rounded; sutures limbate above, oblique, ventrally much depressed; the sides beaded or irregularly ornamented; umbilical region often filled with a rounded mass of material about which is a depressed area, wall otherwise smooth; aperture a very narrow slit on the ventral margin of the chamber.

Diameter 0.60–1 mm.

Distribution.—This species does not seem to have been definitely recorded from the North Pacific. I have it from Cebu, Philippine Islands, collected by Dr. E. A. Mearns, from *Albatross* H4878 in 84 fathoms, bottom temperature 51.9° F., off Japan and D4968 in 253 fathoms, bottom temperature 45.7°, also off Japan. This is essentially a shallow water species and is probably widely distributed in the region under such conditions but material from shallow water has been very scanty.

ROTALIA BROECKHIANA Karrer.

Plate 27, fig. 4; plate 30, fig. 2.

Rotalia broeckhiana Karrer, in Drasche, Geol. Insel. Luzon, 1878, p. 98, pl. 5, fig. 26.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 705, pl. 107, figs. 4*a–c*.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 421, pl. 19, figs. 19–21.—Millett, Journ. Roy. Micr. Soc., 1904, p. 503.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 423.

Description.—Test nearly equally biconvex, nearly circular in side view; chambers 7 or 8 in the final whorl, narrow; sutures slightly depressed, a slight channel between the last formed whorl and the previous one dorsally; umbilical region filled with clear shell material as are also the sutures ventrally; surface smooth; aperture an elongated somewhat arched slit running from near the umbilical region almost to the peripheral margin on the ventral side.

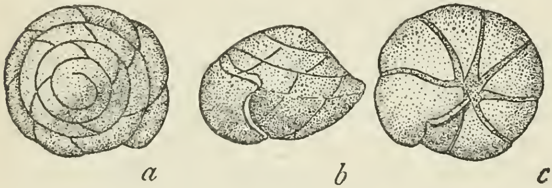


Fig. 61.—Rotalia broeckhiana Karrer. × 50. *a*, dorsal view; *b*, side view; *c*, ventral view. (After Brady.)

Diameter about 0.75 mm.

Distribution.—Apparently this species has not previously been recorded from the North Pacific. The only station from which I have found it is *Nero* 1209 in 660 fathoms, blue mud, off Japan.

ROTALIA ORBICULARIS d'Orbigny.

Plate 29, fig. 3.

Rotalia (*Gyroidina*) *orbicularis* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 278, No. 1; Modèles, No. 13.

Rotalia orbicularis H. B. Brady, Trans. Linn. Soc., London, vol. 24, 1864, p. 470, pl. 48, fig. 16.—Terquem, Mem. Soc. Géol. France, ser. 3, vol. 2, mem. 3, 1882, p. 60, pl. 4, figs. 1–3.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 706, pl. 107, fig. 5; pl. 115, fig. 6.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 421, pl. 19, figs. 22–24.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 5.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 28.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 424.

Description.—Test unequally biconvex, dorsal side flattened but unbonate in the middle, somewhat depressed toward the periphery, ventral side strongly convex, umbilicate; peripheral margin rounded; sutures distinct but not depressed; 10–12 chambers in the final whorl; wall smooth; aperture a narrow slit toward the peripheral margin on the ventral side.

Diameter 0.75–1 mm.

Distribution.—Brady records this species from the North Pacific in 224 to 1,850 fathoms. Flint records it from *Albatross* station D3080 in 93 fathoms off the coast of Oregon. I have failed to find specimens referable to this species.

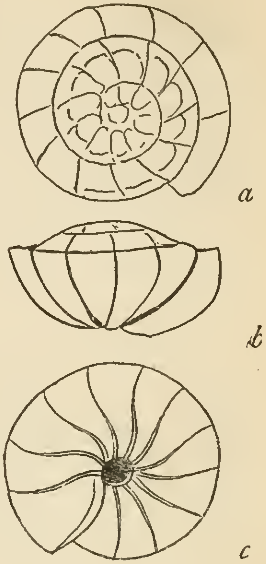


Fig. 62.—Rotalia orbicularis d'Orbigny. × 50. *a*, dorsal view; *b*, side view; *c*, ventral view. (Adapted from Brady.)

ROTALIA CALCAR (d'Orbigny).

Plate 28, fig. 2; plate 29, fig. 2.

Calcarina calcar d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 276, No. 1; Modèles No. 34; in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 93, pl. 5, figs. 22–24.—Carpenter, Parker, and Jones, Introd. Foram., 1862, p. 223, pl. 13, fig. 21.

Rotalia calcar H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 709, pl. 108, fig. 3, fig. 4?—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 423, pl. 19, figs. 1–3.—Millett, Journ. Roy. Micr. Soc., 1904, p. 506.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 140; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 289, pl. 3, fig. 2.

Description.—Test biconvex, composed of numerous chambers with about 10 chambers in the final whorl; sutures limbate both ventrally and dorsally. The peripheral border of each chamber extending out into a spine, central part of the test dorsally with numerous raised tubercles; aperture a narrow, simple slit running ventrally from near the periphery nearly to the umbilicus.

Diameter up to 1.35 mm.

Distribution.—This species seems not to have been previously recorded from the North Pacific. I have had a few specimens from Hong Kong Harbor and from Cebu, Philippines, the latter collected by Dr. E. A. Mearns. Its distribution is apparently limited to the shallow waters of tropical and subtropical regions.

ROTALIA PAPILLOSA H. B. Brady.

Plate 31, fig. 1.

Rotalia papillosa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 708, pl. 106, figs. 9*a–c*.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 76, fig. 2.—Millett, Journ. Roy. Micr. Soc., 1904, p. 505.

Description.—"Test subglobular, slightly compressed; both faces highly convex, periphery obtuse and rounded; composed of three or four convolutions, the last of which has 12 to 14 segments. Sutures limbate; marked externally either by interrupted raised lines, or more frequently by single or double rows of exogenous beads. Umbilical hollow filled with clear shell-substance, the exterior of which is granulated irregularly fissured. Aperture an arched cleft at the inner margin of the inferior face of the final segment, near the periphery.

"Diameter 1/20th inch (1.27 mm.)."

Distribution.—Brady records this species from one North Pacific station, Hong Kong harbor in 7 fathoms. I have had several typical specimens from Hong Kong harbor also. It has occurred as numerous fine specimens at *Albatross* station D4874 in 66 fathoms, eastern channel of Korea Strait. Although the bottom temperature is not given for this station that of surrounding stations runs fairly high and numerous southern species occur here.

This is a beautifully ornamented species and very easily identified.

ROTALIA PAPILLOSA H. B. Brady, var. COMPRESSIUSCULA H. B. Brady.

Plate 30, fig. 1.

Rotalia papillosa H. B. Brady, var. *compressiuscula* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 708, pl. 107, figs. 1*a–c;* pl. 108, figs. 1*a–c*.—Chapman, Trans. New Zealand Inst., vol. 38, 1905, p. 106; Journ. Quekett Micr. Club., ser. 2, vol. 10, 1907, p. 139.

Description.—"General character similar to those of *Rotalia papillosa*, but the test much more compressed and the periphery sharply angular.

"Diameter 1/25th inch (1 mm.)."

Distribution.—Among the original stations for this species Brady records two from the North Pacific, off the Philippines in 95 fathoms and Inland Sea of Japan in 14 fathoms.

I have had specimens from the Inland Sea of Japan collected by Dale and Jouy in 1881 and numerous specimens of the variety with the typical at *Albatross* station D4874 in 66 fathoms, eastern channel of Korea Strait.

At the latter station it was very easy to distinguish between the variety and the typical form especially in size, as well as in the more distinct ornamentation and greater compression of the variety.

ROTALIA SOLDANII d'Orbigny.

Plate 29, fig. 1; plate 31, fig. 4.

Rotalia (*Gyroidina*) *soldanii* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 278, No. 5; Modèles, No. 36.

Rotalia soldanii HANTKEN, Mitth. Jahrb. ung. geol. Anstalt., 1875, p. 80, pl. 9, figs. 7*a–c*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 706, pl. 107, figs. 6, 7.—TERRIGI, Mem. Com. Geol. Italia, vol. 4, 1891, p. 109, pl. 4, fig. 15.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 6, 1899, p. 328, pl. 6, fig. 14.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 332, pl. 75, fig. 4.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 503.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 106; Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 140.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 163.

Rotalia beccarii, var. *soldani* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 389, pl. 16, figs. 31–33.

Rotalia soldanii EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 420, pl. 19, figs. 16–18, 51.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 99, pl. 16, fig. 812.

Description.—Test plano-convex, dorsal side flat or even slightly depressed, especially near the peripheral margin, ventral side very convex; chambers numerous, distinct; the sutures but slightly depressed; wall smooth, thick, finely perforate; umbilicus deeply excavated; aperture an elongate slit at the inner margin of the chamber.

Diameter about 1 mm.

Distribution.—This is a rather widely distributed species in the North Pacific. Brady records it from two *Challenger* stations 214 and 224 in 500 and 1,850 fathoms respectively. Goës records it from *Albatross* station D3433 in 1,218 fathoms. Flint records it from *Albatross* station D3080 in 93 fathoms off the coast of Oregon and Bagg had it from three *Albatross* stations off the Hawaiian Islands, H4508, H4555, and H4585 in 495, 1,398 and 689 fathoms, respectively. I have had material from about the Hawaiian Islands, off the Galapagos Islands, at numerous *Nero* stations between Guam and Japan and also at *Albatross* stations off Japan. The deepest station is 2,048 fathoms and the shallowest 244 fathoms.

Genus CALCARINA d'Orbigny, 1826.

Nautilus (part) LINNÆUS, Syst. Nat., ed. 13 (Gmelin's), 1788, p. 3371.

Calcarina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 276 (type, *Nautilus spengleri* (Linnæus)).

Description.—Test composed of numerous chambers, close coiled, biconvex; periphery usually with radiating spines; chambers visible at least on the ventral side, sometimes on the dorsal side as well; aperture typically consisting of a row of small openings along the inner margin of the apertural face; supplemental skeleton and canal system highly developed.

This genus is represented by several recent species, all of which are characteristic of shallow water of the Tropics, although found as far north as the Mediterranean.

CALCARINA SPENGLERI (Linnæus).

Plate 31, fig. 2.

"Ammonshorn" SPENGLER, Danske Skriften, vol. 1, 1781, p. 379, pl. 2, figs. 9*a–c*.

Nautilus spengleri LINNÆUS, Syst. Nat., ed. 13 (Gmelin's), 1788, p. 3371, No. 10.

Calcarina spengleri D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 276, No. 4.—CARPENTER, Philos. Trans., vol. 150, 1860, p. 548, pls. 19, 20, woodcuts.—CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 216, pl. 13, fig. 21, pl. 14, figs. 1–10, figs. 33–36 in text.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 24, pl. 3, fig. 87.—SCHWAGER, Boll. Com. Geol. Ital., vol. 8, 1877, p. 26, pl., fig. 74.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, 1880, p. 207, pl. 9, fig. 7.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 712, pl. 108, figs. 5, 7.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 423, pl. 19, figs. 4–6.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 597.

Description.—Test lenticular, biconvex; chambers arranged in three or four volutions, each with several chambers, but not distinguishable from the surface except the latter part of the final whorl; wall covered with a thick deposit of calcareous material, the surface with raised tubercles of solid, translucent material; peripheral border typically with large spines, usually simple, subcylindrical; aperture a row of rounded pores along the inner margin of the chamber.

Diameter up to 3 mm. or more.

Distribution.—Apparently this species has not previously been recorded from the North Pacific. A few specimens were obtained from material collected by Capt. John Rodgers of the U. S. Exploring Expedition in Gaspar Straits and a few from material collected by Doctor Mearns at Cagayan, Sulu Islands, and Cebu, Philippines.

In some parts of the Tropics this species is very abundant in shore sands. It is an interesting species with its high development of supplemental skeleton and complex canal system.

CALCARINA HISPIDA H. B. Brady.

Plate 29, figs. 4, 5; plate 31, fig. 3.

Calcarina spengleri, hispid variety CARPENTER, Philos. Trans., vol. 150, 1860, p. 551, pl. 19, figs. 8–11; pl. 20, figs. 6, 8.

Calcarina hispida H. B. BRADY, Proc. Roy. Irish Acad., ser. 2, vol. 2, 1876, p. 590; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 713, pl. 108, figs. 8, 9.—LISTER, Philos. Trans., vol. 186, 1895, p. 437, pl. 8, figs. 34–37.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 597.

Calcarina calcar, var. *hispida* CARTER, Ann. Mag. Nat. Hist., ser. 5, vol. 5, 1880, p. 453.

Description.—Test rotaliform, composed of several coils, each of several chambers, little if at all embracing, not visible from the exterior except the few chambers last formed; peripheral margin with radial spines, short and somewhat flattened; entire surface covered with the supplemental skeleton, ornamented exteriorly with short rather obtuse spines giving the whole test a hispid appearance; aperture a series of pores along the inner margin of the chamber.

Diameter up to 2 mm.

Distribution.—From the records this species does not seem to have been definitely recorded from the North Pacific. It occurred with *C. spengleri* in the U. S. Exploring Expedition from Gaspar Straits. Specimens also occurred in Vincennes or Colnett Strait, *Albatross* H4882, in 248 fathoms, bottom temperature 48.8° F. and in the same region D4922, more common, in 60 fathoms, bottom temperature 79.2° F. This is the region from which so many tropical species of Foraminifera were obtained.

Subfamily 3. TINOPORINÆ.

Test consisting of a close-coiled young followed by chambers irregularly arranged, arborescent, irregular or heaped up into a mass of definite form, either free or attached.

This subfamily consists of three genera as far as the present material is concerned, *Tinoporus,* where the arrangement assumes a regular form, *Gypsina,* where the arrangement in our species is very irregular, and *Polytrema,* where the chambers are arranged in an arborescent form.

Most of the living species seem to be characteristic of shallow water of tropical or subtropical regions.

Genus TINOPORUS (emend.) Carpenter, 1860.

Tinoporus Montfort (type, *T. baculatus* Montfort), Conch. Syst., vol. 1, 1808, p. 146.—Carpenter, (Emend.) Philos. Trans., 1860, p. 557.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 714.

Description.—Test free, biconvex, composed of numerous chambers in a mass, the early ones spirally arranged; surface reticulated, with raised tubercles occupying some of the angles of the meshes of the surface; outer walls of the chambers coarsely porous; periphery with several spines.

This genus is an interesting one, only its early chambers showing its real relation to the other members of the Rotaliidæ.

TINOPORUS BACULATUS [Montfort?] Carpenter.

Plate 27, fig. 3.

Tinoporus baculatus (?) Montfort, Conch. Syst., vol. 1, 1808, p. 146.

Tinoporus baculatus Carpenter, Philos. Trans., 1860, p. 557, 564, pl. 18, figs. 2–10; pl. 21, figs. 5–11.—Carpenter, Parker, and Jones, Int. Foram., 1862, p. 226, pl. 15, figs. 5–12.—Bütschli, in Bronn, Klassen und Ordnungen Thier-Reichs, 1880, p. 216, pl. 13, fig. 3.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 716, pl. 101, figs. 4–7.—Dervieux, Atti R. Accad. Sci. Torino, vol. 29, 1893, p. 6, pl., figs. 19, 26, 34.—Sherlock, Bull. Mus. Comp. Zoöl., vol. 38, 1903, p. 357, fig. 8.—Millett, Journ. Roy. Micr. Soc., 1904, p. 598.—Chapman, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 424.

Description.—Test free, large, composed of an early coiled portion which is soon inclosed by an irregularly massed group of chambers forming the test; biconvex and with a few very coarse short grooved spines at the periphery; the sutures between the chambers usually marked at their intersections by raised bosses, the whole forming a reticulate network.

Diameter up to 3 mm.

Distribution.—In the North Pacific this species has been recorded by Brady, the *Challenger* having obtained it from the shore sands of the Philippines. It is a species of shallow tropical waters.

Genus GYPSINA Carter, 1877.

Gypsina CARTER (type, *G. vesicularis* (Parker and Jones)), Ann. Mag. Nat. Hist., ser. 4, vol. 20, 1877, p. 173.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 716.

Description.—Test free or adherent, when free it may be spherical or compressed, when adherent the test takes the form of the object to which it is attached or becomes a raised mass of chambers more or less symmetrical; early chambers forming a flat spire in the higher species, but in most irregularly arranged throughout; wall coarsely porous.

There has been some question as to whether the species now placed in this genus belonged to the Foraminifera or elsewhere in the animal kingdom. They seem to have sufficient characters, especially in the higher species, to place them with the Rotaliidæ.

GYPSINA INHÆRENS (Schultze).

Plate 21, figs. 6, 7.

Acervulina inhærens SCHULTZE, Organ. der Polythal., 1854, p. 68, pl. 6, fig. 12.

Gypsina inhærens H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 718, pl. 102, figs. 1-6.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 229, pl. 41, fig. 19.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 91, pl. 15, fig. 787.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 336, pl. 79, fig. 6.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 599.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 72, pl. 5, fig. 60.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 11.

Description.—Test adherent, early portion discoidal, later adapting its shape to the surface to which it is attached, composed of numerous chambers, the earliest ones often showing a spiral arrangement, the later ones irregularly massed; sutures distinct, slightly depressed; surface conspicuously punctate.

Diameter up to 1.50 mm.

Distribution.—Rhumbler records this species from shallow water off Laysan Island. There are no other North Pacific records. This is essentially a species of shallow waters of tropical or subtropical seas, although there are records for it in some of the warmer portions of the temperate zone.

Genus POLYTREMA Risso, 1826.

Millepora (part) LINNÆUS, Syst. Nat., ed. 13 (Gmelin's) vol. 1, 1788, p. 3784.

Polytrema RISSO (type, *P. corallina* Risso), Hist. Nat. Europ. Mérid., vol. 5, 1826, p. 340.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 719.

Pustularia GRAY, Proc. Zool. Soc. London, vol. 26, 1858, p. 271.

Description.—Test adherent; early chambers small, spirally arranged, soon covered by the irregular loosely growing chambers making an irregular spreading mass, later chambers forming an arborescent growth; wall calcareous, areolated, numerous apertures appearing at the surface on papillæ; interior often of loosely arranged chambers with lacunæ between; color red or pink or sometimes white.

This genus was for a long time considered as belonging to the old group of "Zoophytes." Its external appearance is sufficient for an understanding of this error but a study of the structure shows it to be a foraminifer. The early chambers with their spiral growth place it with *Discorbina* and other genera of the Rotaliidæ. It is a rather unusual type of the group and is usually found in comparatively shallow water of coral reefs in abundance but ranges out of the tropics both north and south and is found in as great depths as 1,000 fathoms, according to the *Challenger* Report.

POLYTREMA MINIACEUM (Linnæus).

Plate 18, fig. 6; plate 20, fig. 4.

Millepora miniacea LINNÆUS, Syst. Nat., ed. 13 (Gmelin's), vol. 1, pt. 6, 1788, p. 3784, No. 6.

Polytrema miniaceum BLAINVILLE, Dict. Sci. Nat., vol. 42, 1826, Atlas, Zooph., vol. 1, p. 17; ?Actinologie, 1834, pp. 410, 673, pl. 69, figs. 4, 4*a*.—CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 235, pl. 13, figs. 18–20.—CARTER, Ann. Mag. Nat. Hist., ser. 4, vol. 17, 1876, p. 185, pl. 13, figs. 1–6.—MOEBIUS, Foram. von Mauritius, 1880, p. 85, pl. 7.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 721, pl. 100, figs. 5–9, pl. 101, fig. 1.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 437, pl. 21, figs. 1, 2, 16, 17.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, pt. 3, 1910, p. 29.

Description.—Test attached, early portion close coiled, consisting of several chambers, later portion consisting of a mass of small chambers arranged in irregular layers, whole more or less arborescent; surface with conspicuous apertural openings; wall areolated; color various shades of red.

Length up to 5 mm or more.

Distribution.—This species is apparently not definitely recorded from the North Pacific. The only material I have had was from *Albatross* station D 4922 in Vincennes or Colnett Strait in 60 fathoms bottom temperature 79.2° F.

This is typically a species of warm waters, attached to various objects and does not at all resemble the usual forms of Foraminifera. Only its early chambers, which can not be seen except by breaking away the specimen, show the close coiled, several chambered young, which indicate its relationship to the other members of this family.

EXPLANATION OF PLATES.

Plate 1.

Fig. 1. *Spirillina vivipara.* × 100. *a*, side view; *b*, peripheral view. (After Brady.)
2. *Spirillina vivipara.* × 100. (After Brady.)
3. *Spirillina vivipara*, var. *revertens.* × 250. (After Rhumbler.)
4. *Spirillina vivipara*, var. *revertens.* × 250. (After Rhumbler.)
5. *Spirillina vivipara*, var. *revertens.* × 100. (After Brady.)
6. *Spirillina vivipara*, var. *revertens.* × 250. (After Rhumbler.)
7. *Spirillina tuberculata.* × 50. (After Brady.)
8. *Spirillina tuberculata.* × 50. (After Brady.)
9. *Spirillina tuberculata.* × 50. (After Brady.)

Plate 2.

Fig. 1. *Spirillina limbata.* × 50. *a*, side view; *b*, peripheral view. (After Brady.)
2. *Spirillina limbata.* × 60. *a*, side view; *b*, peripheral view. (After Brady.)
3. *Spirillina tuberculata.* × 45. (After Brady.)
4. *Spirillina limbata*, var. *papillosa.* × 100. *a*, from above; *b*, from below; *c*, from periphery.

Plate 3.

Fig. 1. *Spirillina limbata*, var. *denticulata.* × 100. *a*, from above; *b*, from below; *c*, from periphery. (After Brady.)
2. *Spirillina limbata*, var. *denticulata.* × 50. *a*, from above; *b*, from below; *c*, from periphery.
3. *Spirillina inæqualis.* × 120. (After Brady.)

Plate 4.

Fig. 1. *Spirillina guttata.* × 65. *a*, from above; *b*, from below; *c*, from periphery.
2. *Spirillina operculoides.* × 65. *a*, from above; *b*, from below; *c*, from periphery.
3. Spirillina-like operculrum. × 65. *a*, from above: *b* from below; *c*, from periphery.

Plate 5.

Fig. 1. *Spirillina decorata.* × 50. *a*, from above; *b*, from periphery. (After Brady.)
2. *Spirillina decorata.* × 50. (After Brady.)
3. *Discorbis concinna.* × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
4. *Discorbis tabernacularis.* × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
5. *Discorbis patelliformis.* × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)

Plate 6.

Fig. 1. *Discorbis isabelleana.* × 75. *a*, from above; *b*, from below; *c*, from side.
2. *Discorbis subfilosa.* × 75. *a*, from above; *b*, from below; *c*, from side.
3. *Discorbis pulvinulinoides.* × 75. *a*, from above; *b*, from below.

PLATE 7.

Fig. 1. *Patellina corrugata.* × 120. *a*, from above; *b*, from below. (After Brady.)
2. *Discorbis pulvinata.* × 100. *a*, from above; *b*, from side. (After Brady.)
3. *Discorbis bertheloti.* × 90. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
4. *Discorbis rarescens.* × 75. *a*, from above; *b*, from below; *c*, from side. (After Brady.)

PLATE 8.

Fig. 1. *Discorbis globularis*, var. *bradyi.* × 75. *a*, from above; *b*, from below; *c*, from side.
2. *Planorbulina larvata.* × 38. *a*, from above; *b*, from below; *c*, from side.

PLATE 9.

Fig. 1. *Discorbis allomorphinoides* × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
2. *Discorbis vilardeboana.* × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
3. *Discorbis auracana.* × 75. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
4. *Discorbis globularis.* × 50. *a*, from above; *b*, from below; *c*, from side. (After Brady.)

PLATE 10.

Fig. 1. *Cymbalopora poeyi.* × 65. *a*, from above; *b*, from below; *c*, from side.
2. *Cymbalopora poeyi*, var. *bradyi.* × 65. *a*, from above; *b*, from below; *c*, from side.

PLATE 11.

Fig. 1. *Discorbis orbicularis.* × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
2. *Discorbis turbo.* × 60. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
3. *Discorbis opercularis.* × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)

PLATE 12.

Fig. 1. *Planorbulina mediterranensis.* × 75. *a*, from above; *b*, from below; *c*, from side.
2. *Truncatulina refulgens.* × 75. *a*, from above; *b*, from below; *c*, from side.
3. *Truncatulina wuellerstorfi.* × 38. *a*, from above; *b*, from below; *c*, from side.

PLATE 13.

Fig. 1. *Discorbis ventricosa.* × 50. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
2. *Discorbis irregularis.* (After Rhumbler.)
3. *Discorbis irregularis.* (After Rhumbler.)
4. *Truncatulina mundula.* × 40. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
5. *Truncatulina haidingerii.* × 30 *a*, from above; *b*, from below; *c*, from side. (After Brady).

PLATE 14

Fig. 1. *Planorbulina acervalis.* × 35. (After Brady.)
2. *Cymbalopora poeyi*, var. *bradyi.* × 50. *a*, from above; *b*, from below; *c*, from side. (After Brady.)
3. *Tretomphalus bulloides.* × 60. (After Brady.)
4. *Tretomphalus bulloides.* × 60. (After Brady.)
5. *Cymbalopora poeyi.* × 50. *a*, from above; *b*, from below; *c*, from side. (After Brady.)

PLATE 15.

Fig. 1. *Truncatulina lobatula.* × 65. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Truncatulina dutemplei.* × 65. *a*, dorsal view; *b*, ventral view; *c*, side view.
3. *Truncatulina tumidula.* × 125. *a*, dorsal view; *b*, ventral view; *c*, side view.

PLATE 16.

Fig. 1. *Truncatulina culter.* × 90. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
2. *Truncatulina tenera.* × 75. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
3. *Truncatulina akneriana.* × 45. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
4. *Siphonina reticulata.* × 100. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)

PLATE 17.

Fig. 1. *Truncatulina margaritifera.* × 33. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Truncatulina ungeriana.* × 66. *a*, dorsal view; *b*, ventral view; *c*, side view.

PLATE 18.

Fig. 1. *Siphonina echinata.* × 100. (After Brady.)
2. *Siphonina echinata.* × 100. (After Brady.)
3. *Siphonina echinata.* × 100. (After Brady.)
4. *Siphonina echinata.* × 100. (After Brady.)
5. *Anomalina coronata.* × 40. *a*, dorsal view; *b*, side view. (After Brady.)
6. *Polytrema miniaceum.* × 20. (After Brady.)

PLATE 19.

Fig. 1. *Anomalina ariminensis.* × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Anomalina ammonoides.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
3. *Anomalina polymorpha.* × 30.
4. *Anomalina polymorpha.* × 30.

PLATE 20.

Fig. 1. *Anomalina grosserugosa.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Carpenteria proteiformis.* × 30.
3. *Carpenteria monticularis.* × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.
4. *Polytrema miniaceum.* × 30.

PLATE 21.

Fig. 1. *Carpenteria proteiformis.* × 18. (After Brady.)
2. *Rupertia stabilis.* × 40. (After Brady.)
3. *Rupertia stabilis.* × 40. (After Brady.)
4. *Rupertia stabilis.* × 40. (After Brady.)
5. *Rupertia stabilis.* × 40. (After Brady.)
6. *Gypsina inhærens.* × 30. (After Brady.)
7. *Gypsina inhærens.* × 30. (After Brady.)

PLATE 22.

Fig. 1. *Pulvinulina auricula.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Pulvinulina menardii.* × 30. *a*, dorsal view; *b*, ventral view.
3. *Pulvinulina tumida.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
4. *Pulvinulina hauerii.* × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.

PLATE 23.

Fig. 1. *Pulvinulina canariensis.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Pulvinulina pauperata*—young specimen. × 30.
3. *Pulvinulina pauperata*—adult specimen. × 30.
4. *Pulvinulina truncatulinoides.* × 60. *a*, dorsal view; *b*, ventral view.
5. *Pulvinulina exigua.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
6. *Truncatulina tenera.* × 50. *a*, dorsal view; *b*, ventral view; *c*, side view.

PLATE 24.

Fig. 1. *Pulvinulina punctulata.* × 16. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
2. *Pulvinulina procera.* × 35. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
3. *Pulvinulina repanda* × 40. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)

PLATE 25.

Fig. 1. *Pulvinulina concamerata.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Pulvinulina procera.* × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.

PLATE 26.

Fig. 1. *Pulvinulina karsteni.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Truncatulina præcincta.* × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.
3. *Pulvinulina elegans.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.

PLATE 27.

Fig. 1. *Pulvinulina crassa.* × 40. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
2. *Pulvinulina umbonata.* × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
3. *Tinoporus baculatus.* × 30. *a*, dorsal view; *b*, side view. (After Brady.)
4. *Rotalia broeckhiana.* × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
5. *Pulvinulina oblonga*, var. *scabra.* × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)

PLATE 28.

Fig. 1. *Truncatulina haidingerii.* × 65. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Rotalia calcar.* × 65. *a*, dorsal view; *b*, ventral view; *c*, side view.
3. *Siphonina reticulata.* × 125.
4. *Pulvinulina concentrica.* × 38. *a*, dorsal view; *b*, ventral view; *c*, side view.

PLATE 29.

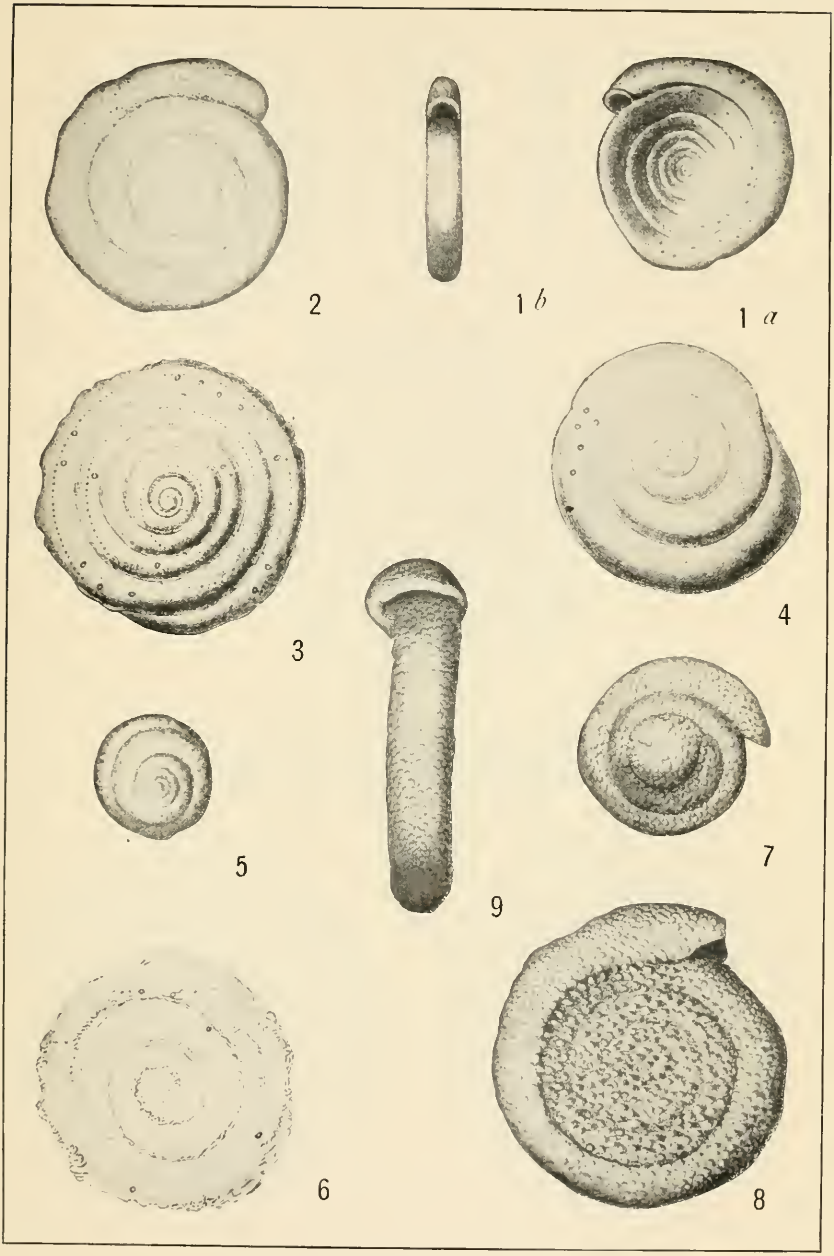
Fig. 1. *Rotalia soldani.* × 40. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
2. *Rotalia calcar.* × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
3. *Rotalia orbicularis.* × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)
4. *Calcarina hispida.* × 30. (After Brady.)
5. *Calcarina hispida.* × 30. (After Brady.)

PLATE 30.

1. *Rotalia papillosa*, var. *compressiuscula.* × 33. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Rotalia broeckhiana.* × 66. *a*, dorsal view; *b*, ventral view; *c*, side view.
3. *Rotalia beccarii.* × 33. *a*, dorsal view; *b*, ventral view; *c*, side view.

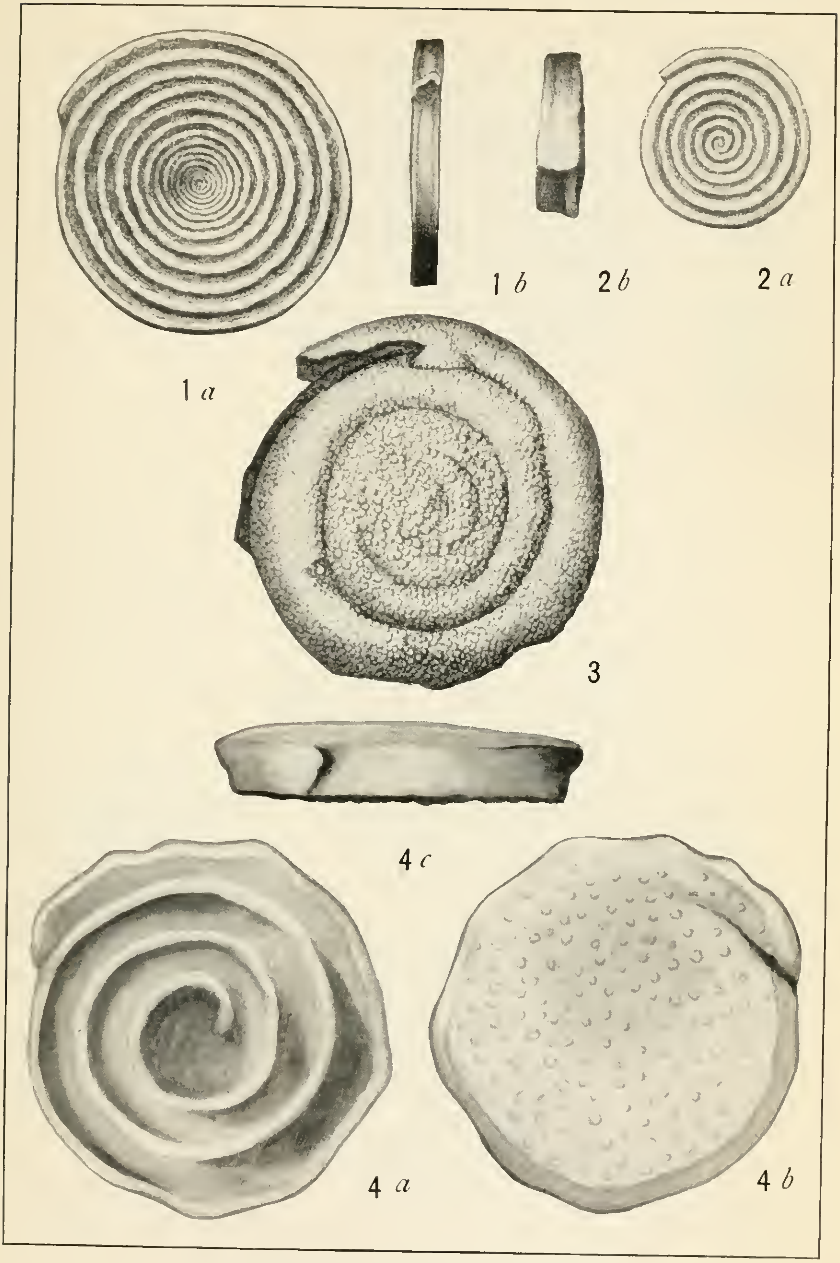
PLATE 31.

Fig. 1. *Rotalia papillosa.* × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.
2. *Calcarina spengleri.* × 30. *a*, dorsal view; *b*, ventral view.
3. *Calcarina hispida.* × 30.
4. *Rotalia soldanii.* × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.


2
1 *b*
1 *a*
3
4
5
7
9
6
8

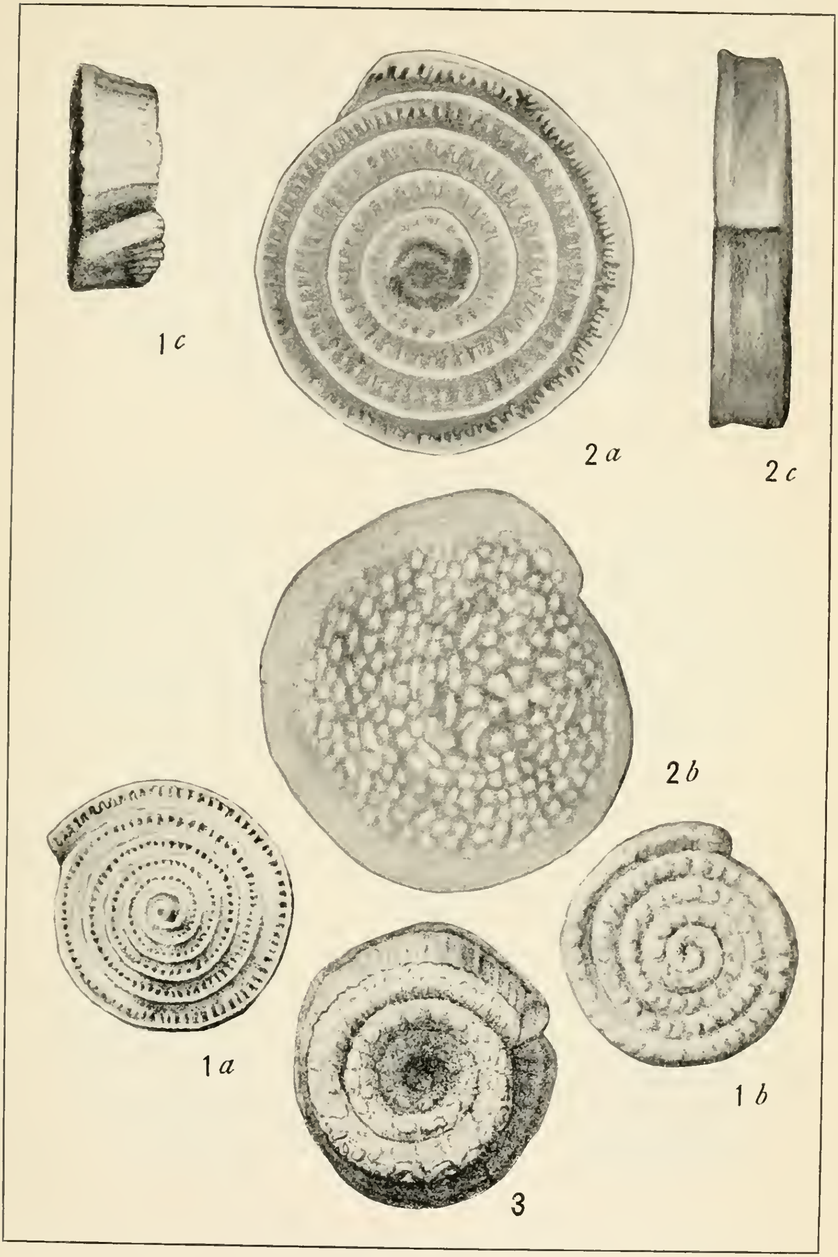
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 77.


1 *a*
1 *b*
2 *b*
2 *a*
3
4 *c*
4 *a*
4 *b*

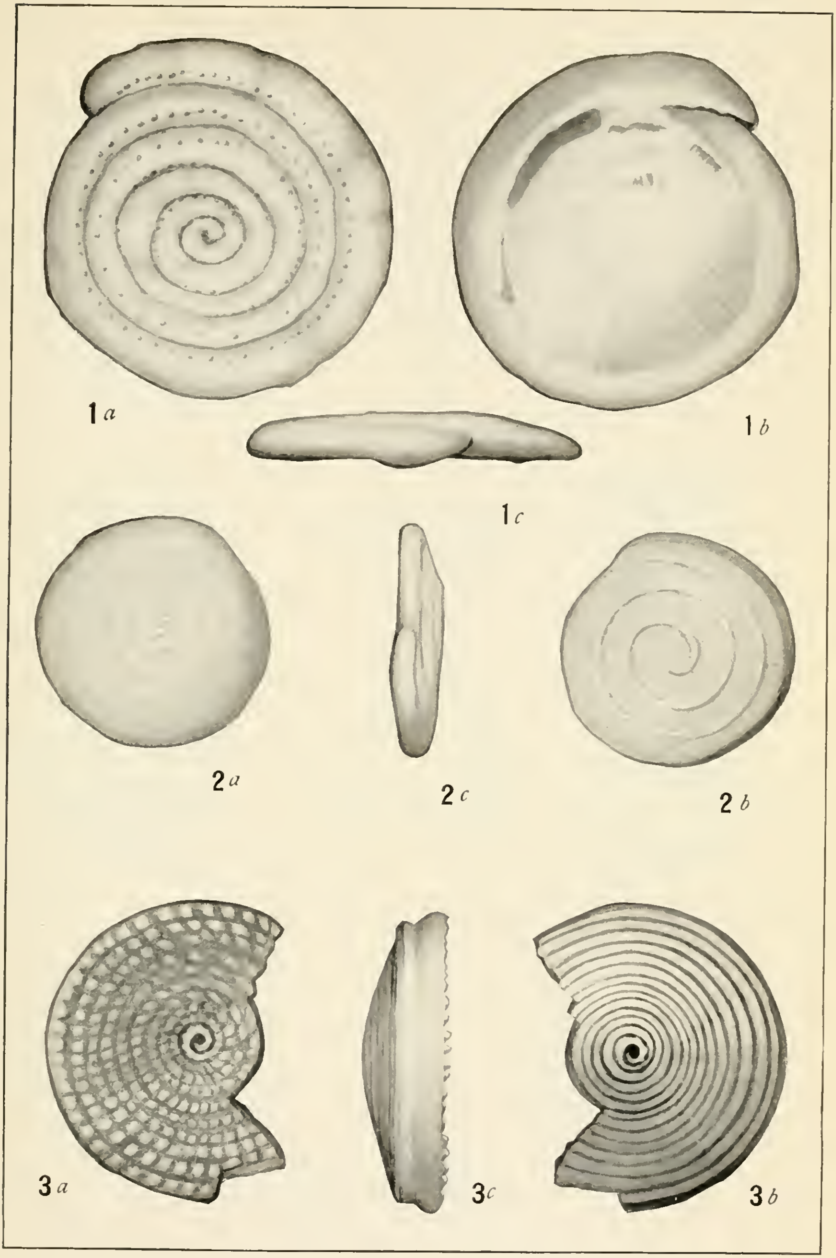
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 77.


1 c
2 a
2 c
2 b
1 a
1 b
3

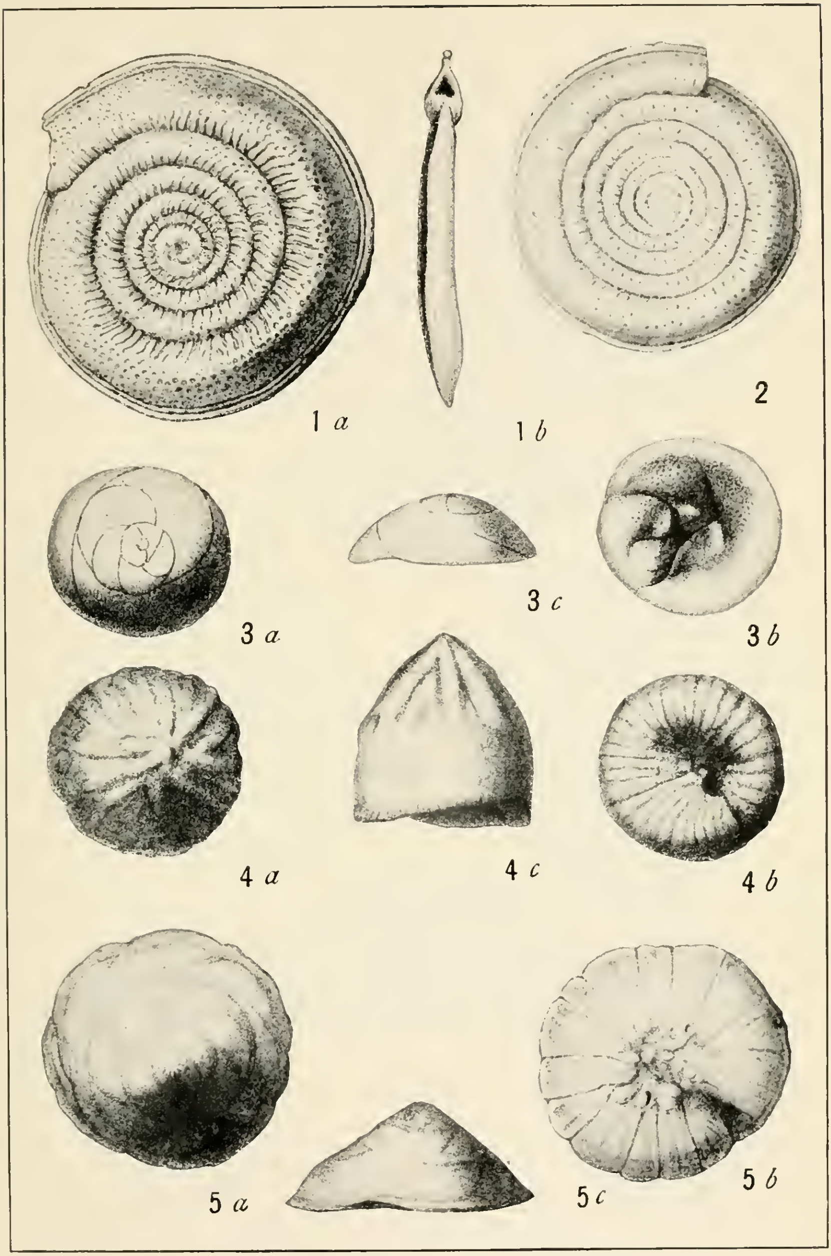
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 77.


1a
1b
1c
2a
2c
2b
3a
3c
3b

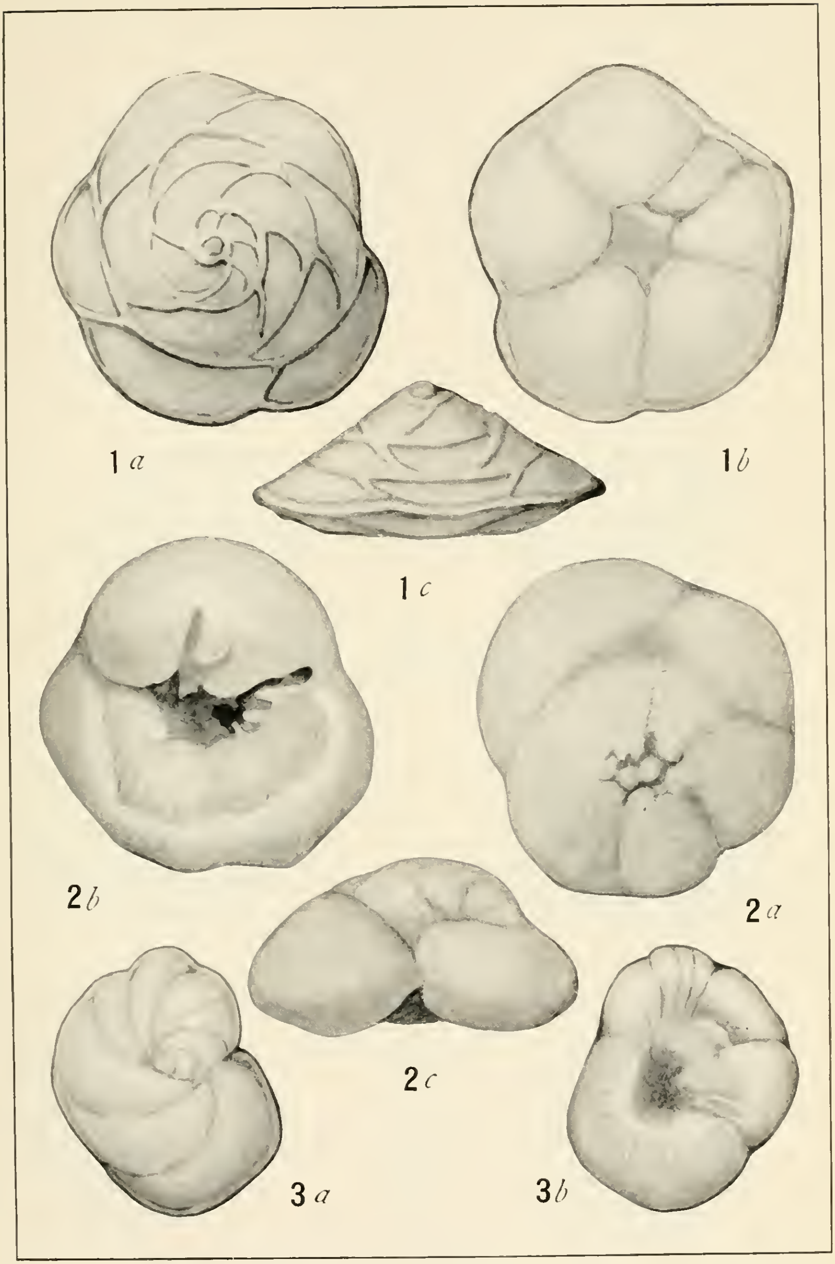
Rotaliidæ of North Pacific Ocean.

For explanation of plate see page 77.


1 *a*
1 *b*
2
3 *a*
3 *c*
3 *b*
4 *a*
4 *c*
4 *b*
5 *a*
5 *c*
5 *b*

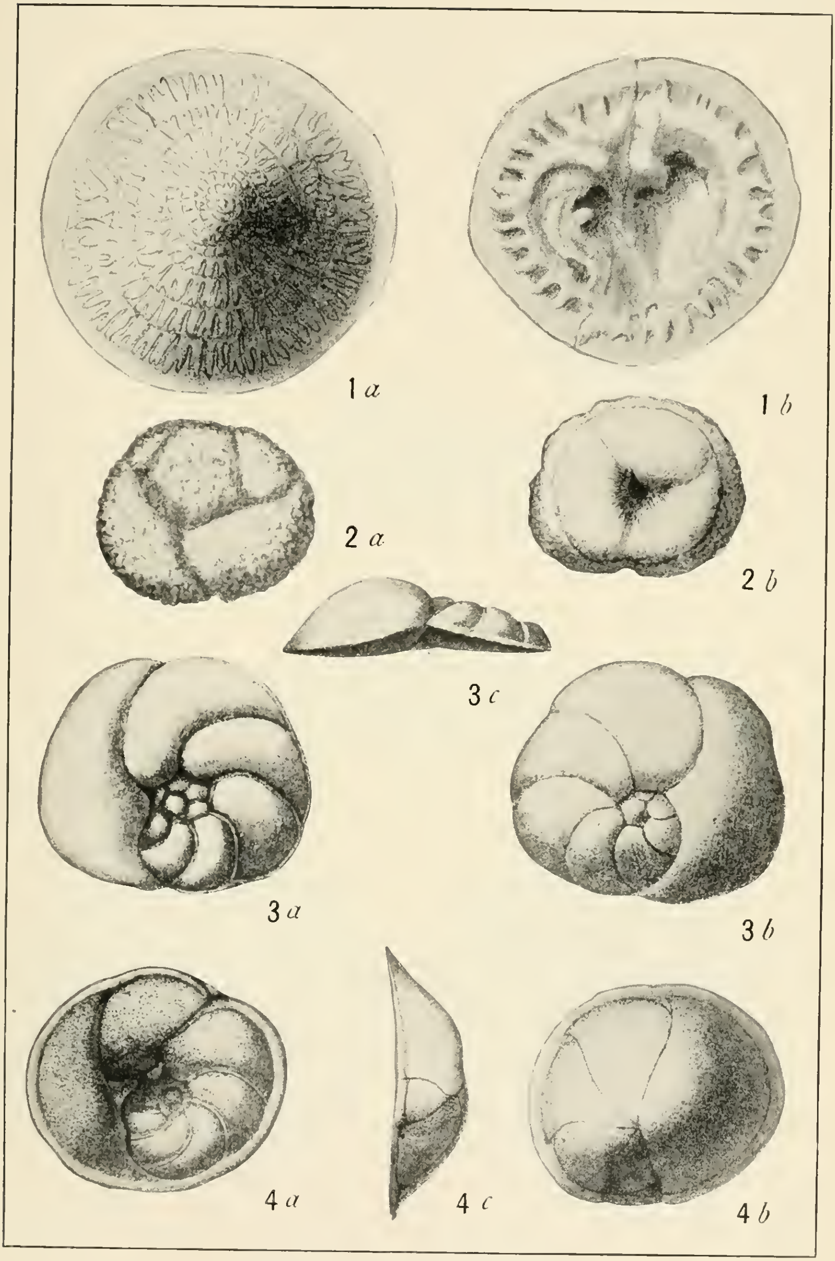
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 77.


1 a
1 b
1 c
2 b
2 a
2 c
3 a
3 b

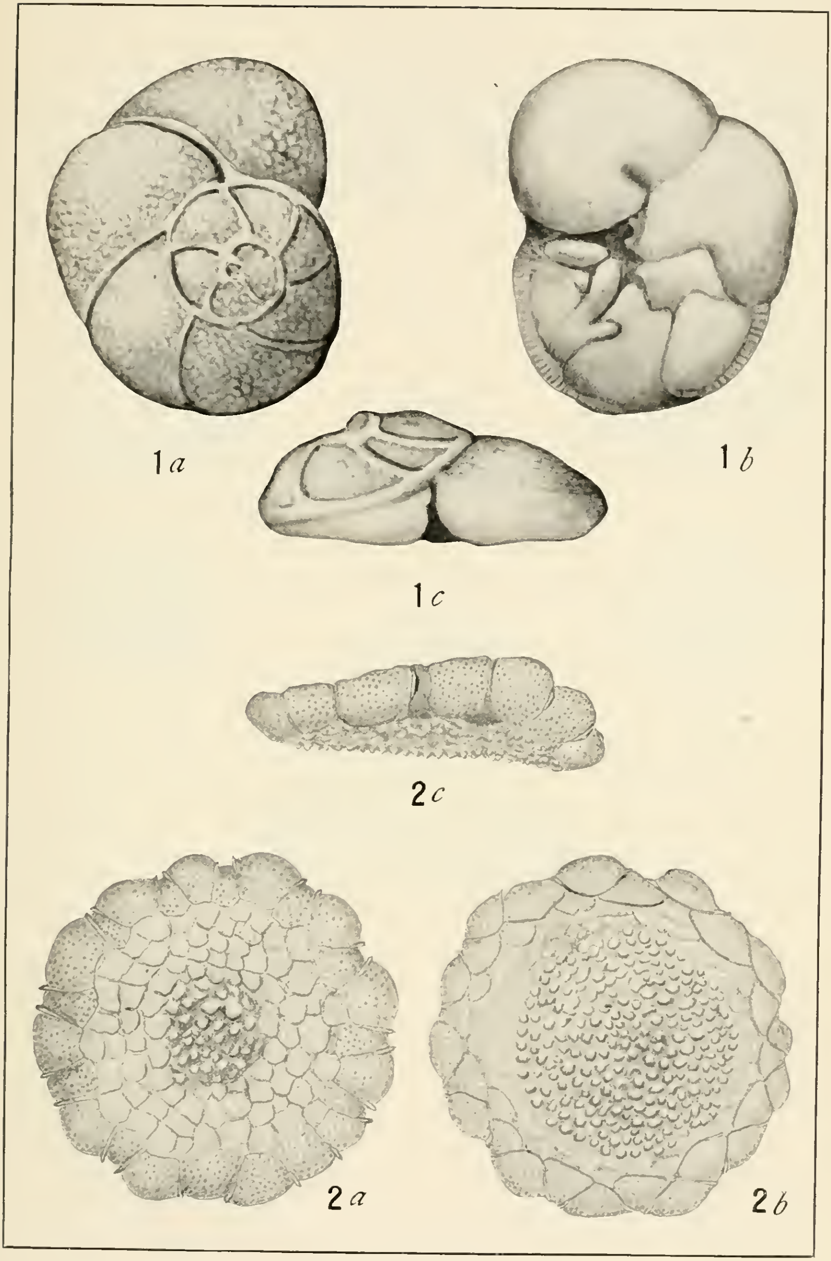
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 77.


1 a
1 b
2 a
2 b
3 c
3 a
3 b
4 a
4 c
4 b

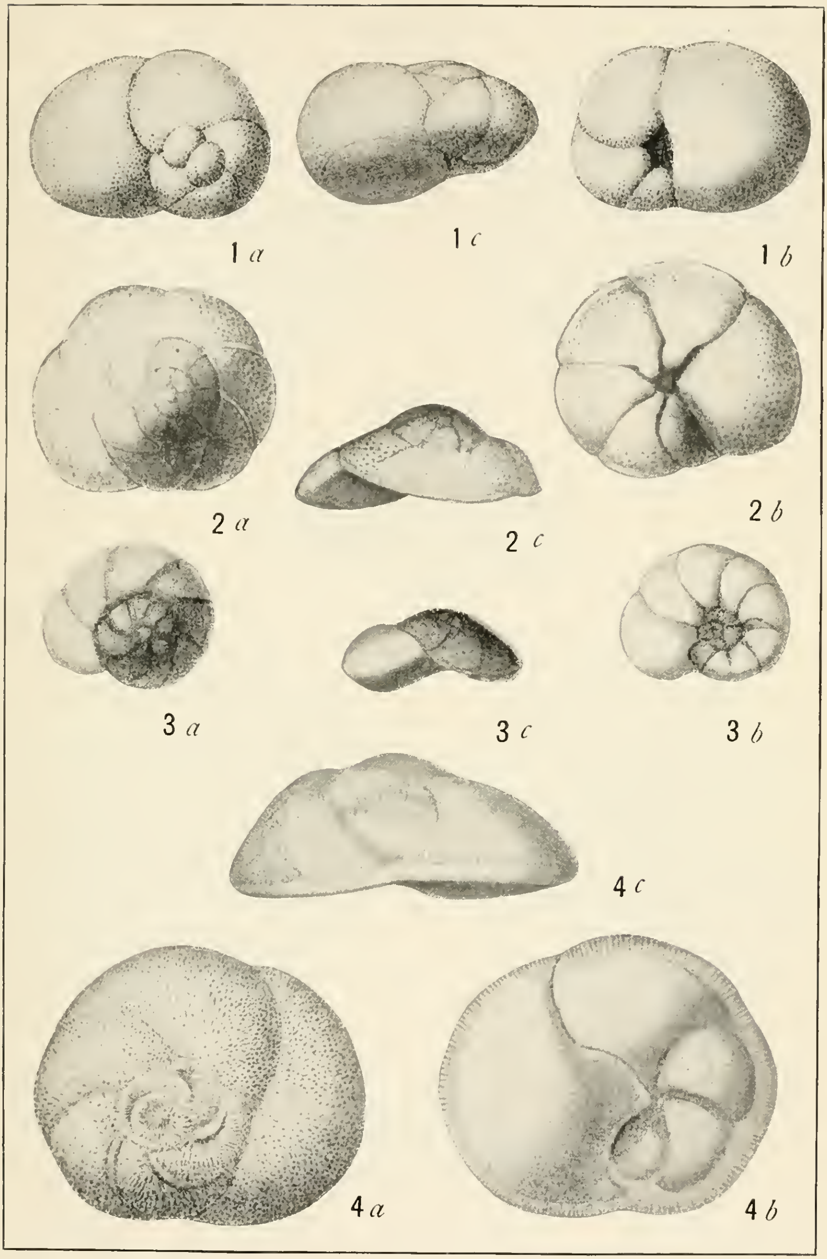
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 77.


1a
1b
1c
2c
2a
2b

Rotaliidæ of North Pacific Ocean.

For explanation of plate see page 78.


1 a
1 c
1 b
2 a
2 c
2 b
3 a
3 c
3 b
4 c
4 a
4 b

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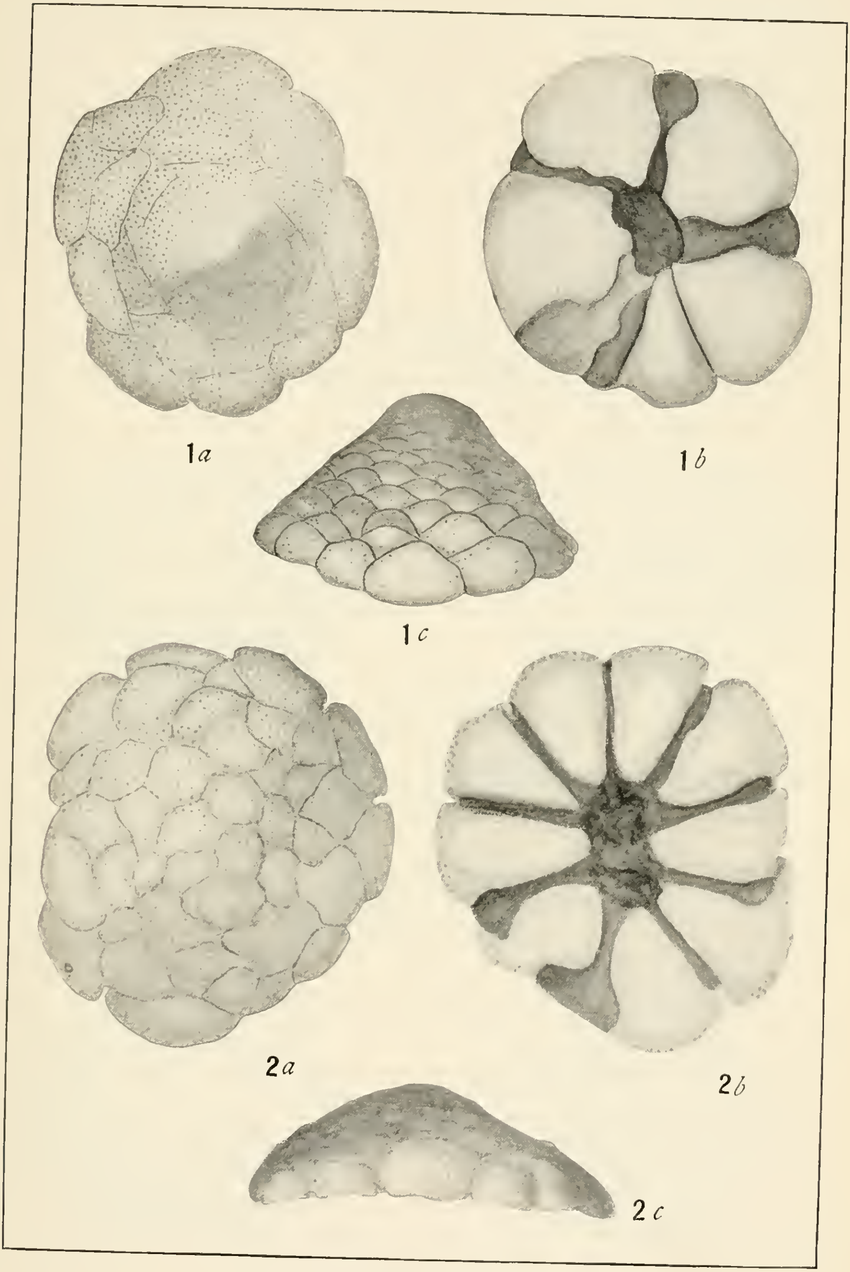
For explanation of plate see page 78.


1a
1b
1c
2a
2b
2c

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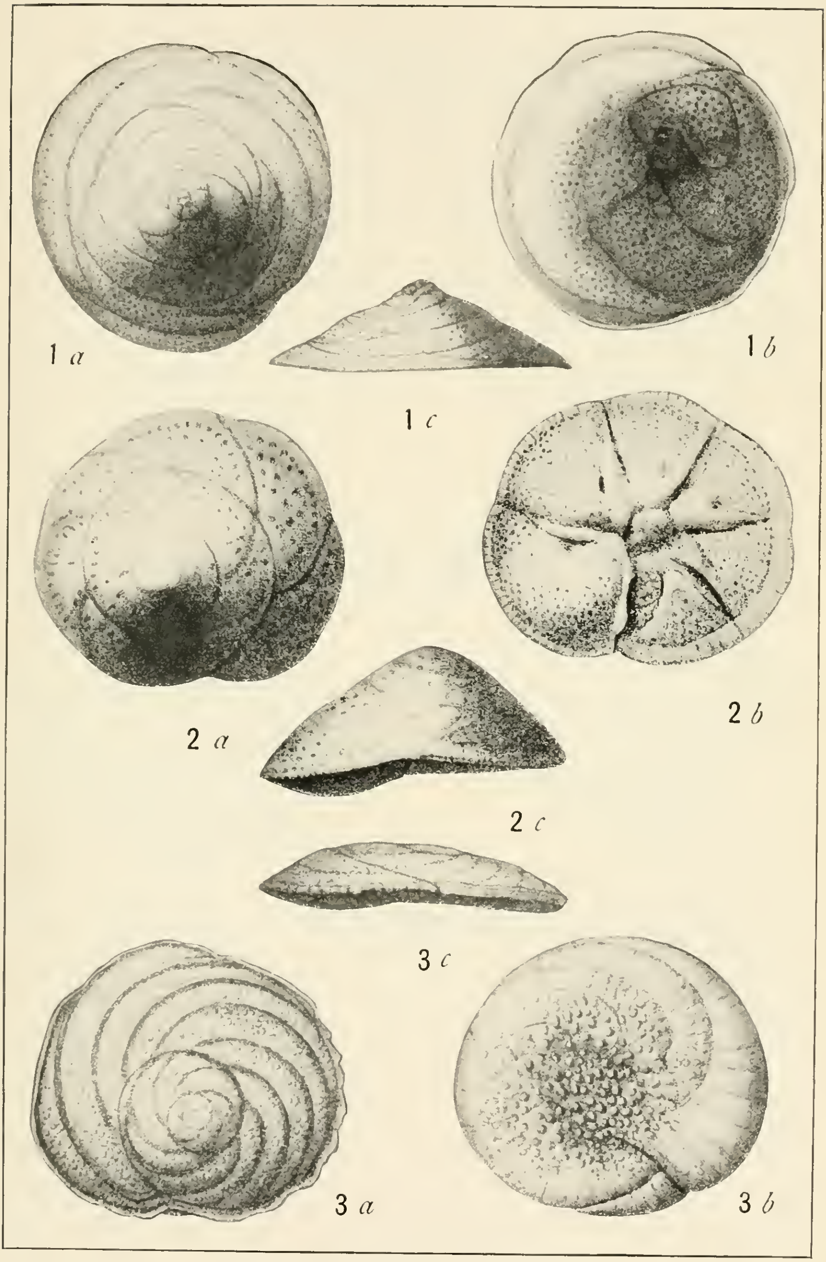
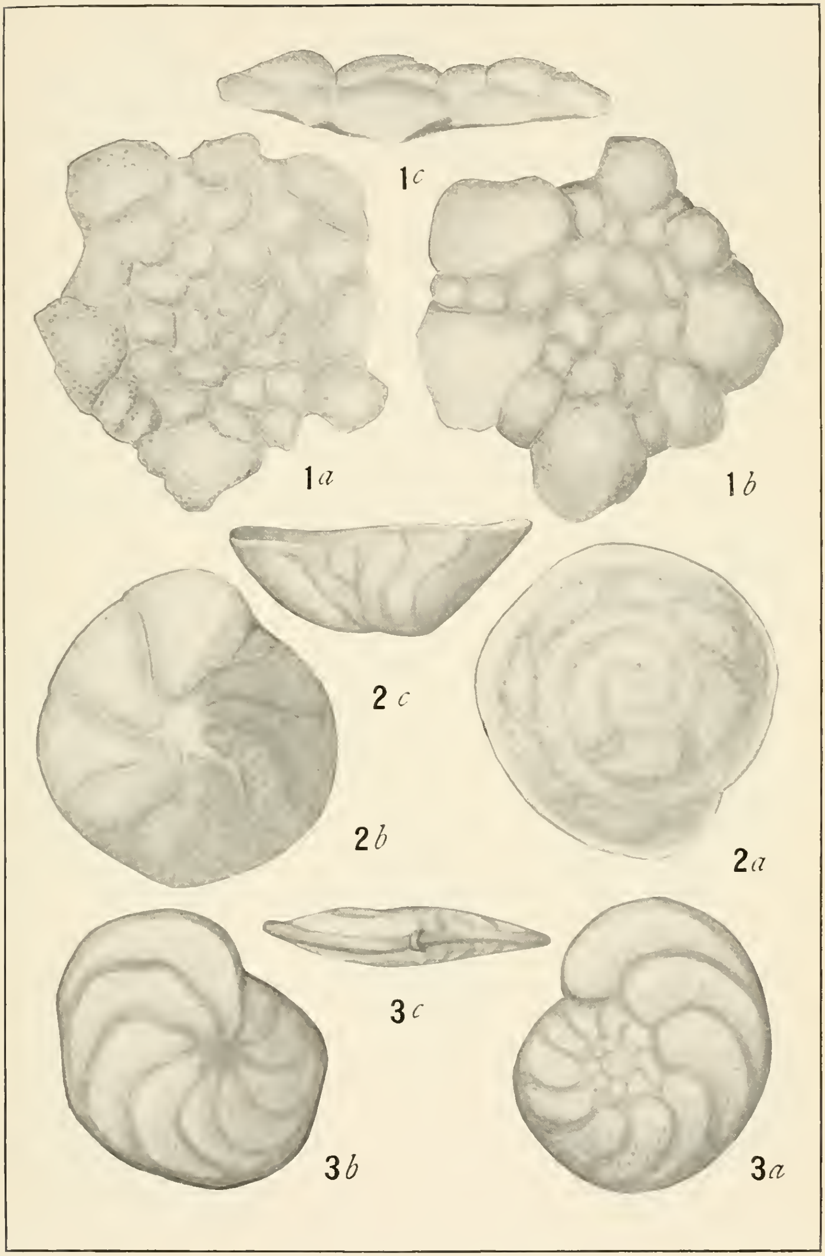

1 a
1 b
1 c
2 a
2 b
2 c
3 c
3 a
3 b

ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 78.


1c
1a
1b
2c
2b
2a
3c
3b
3a

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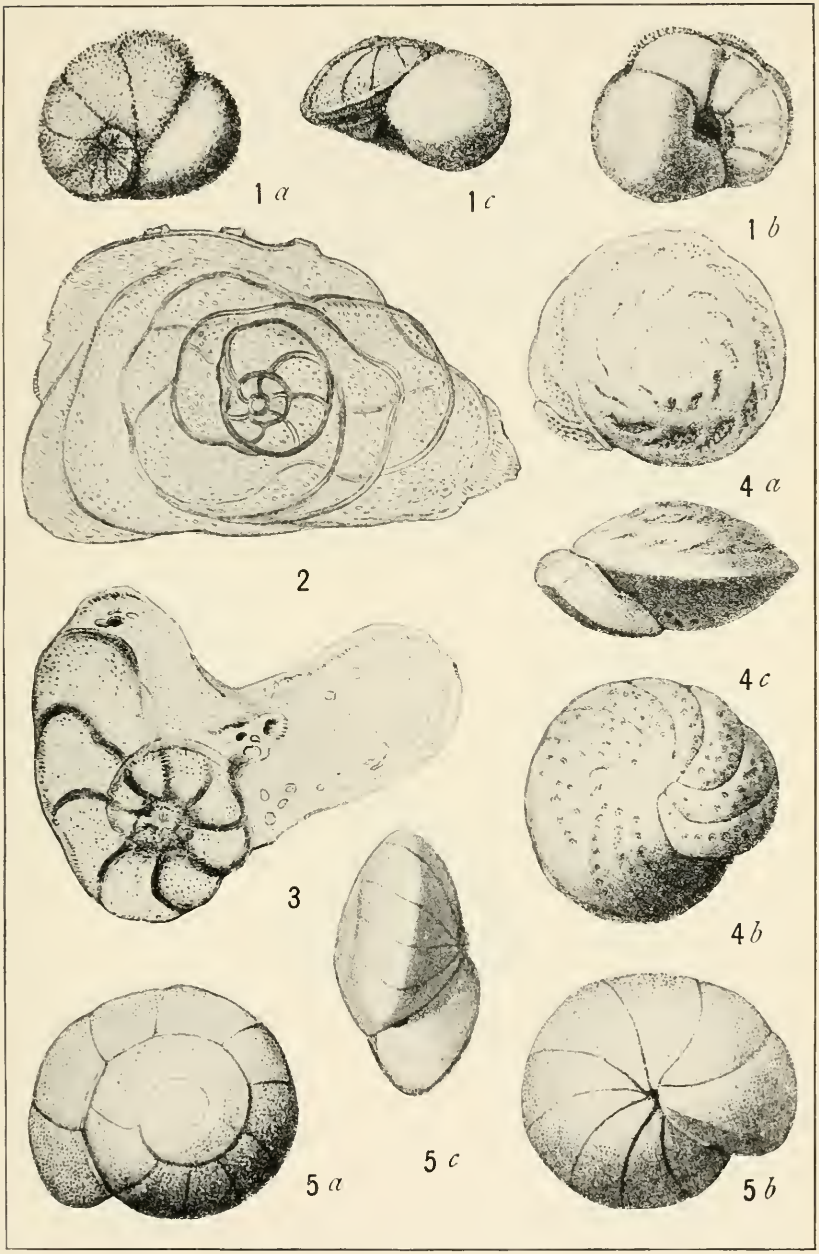
1 *a*
1 *c*
1 *b*
2
4 *a*
4 *c*
3
4 *b*
5 *c*
5 *a*
5 *b*

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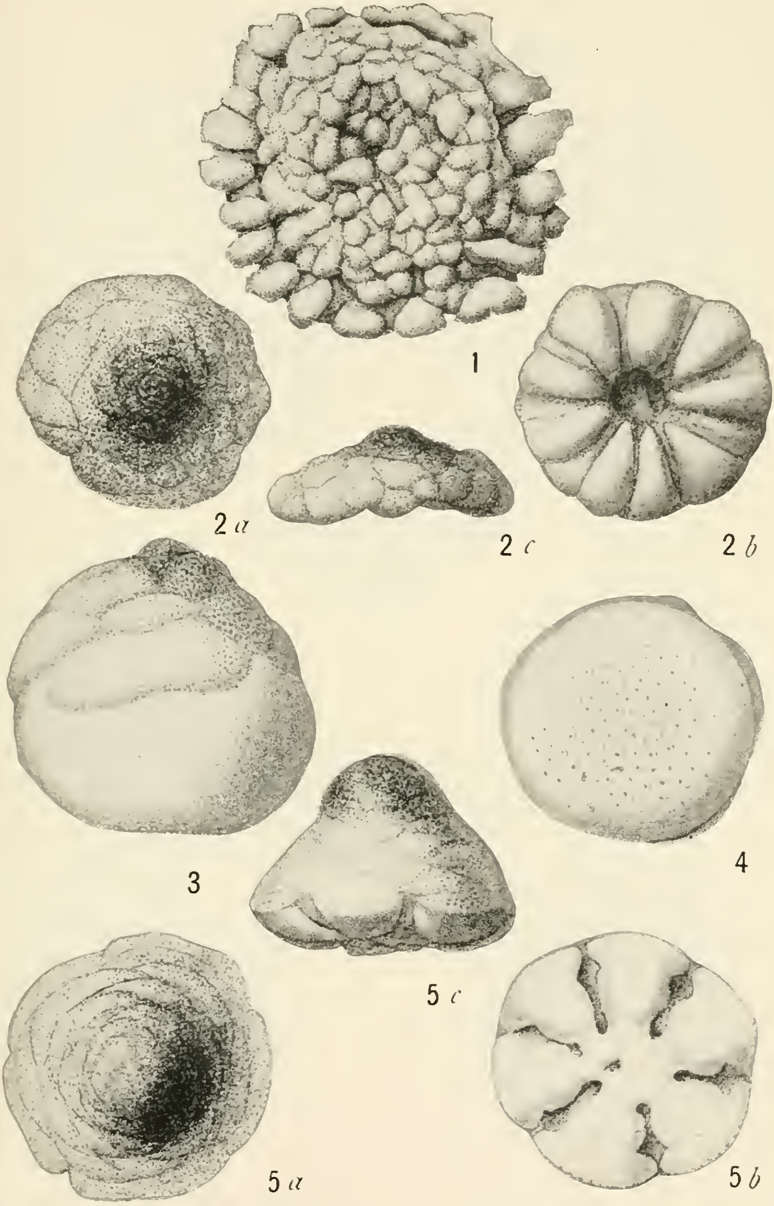
FOR EXPLANATION OF PLATE SEE PAGE 78.


1
2 a
2 c
2 b
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5 c
5 a
5 b

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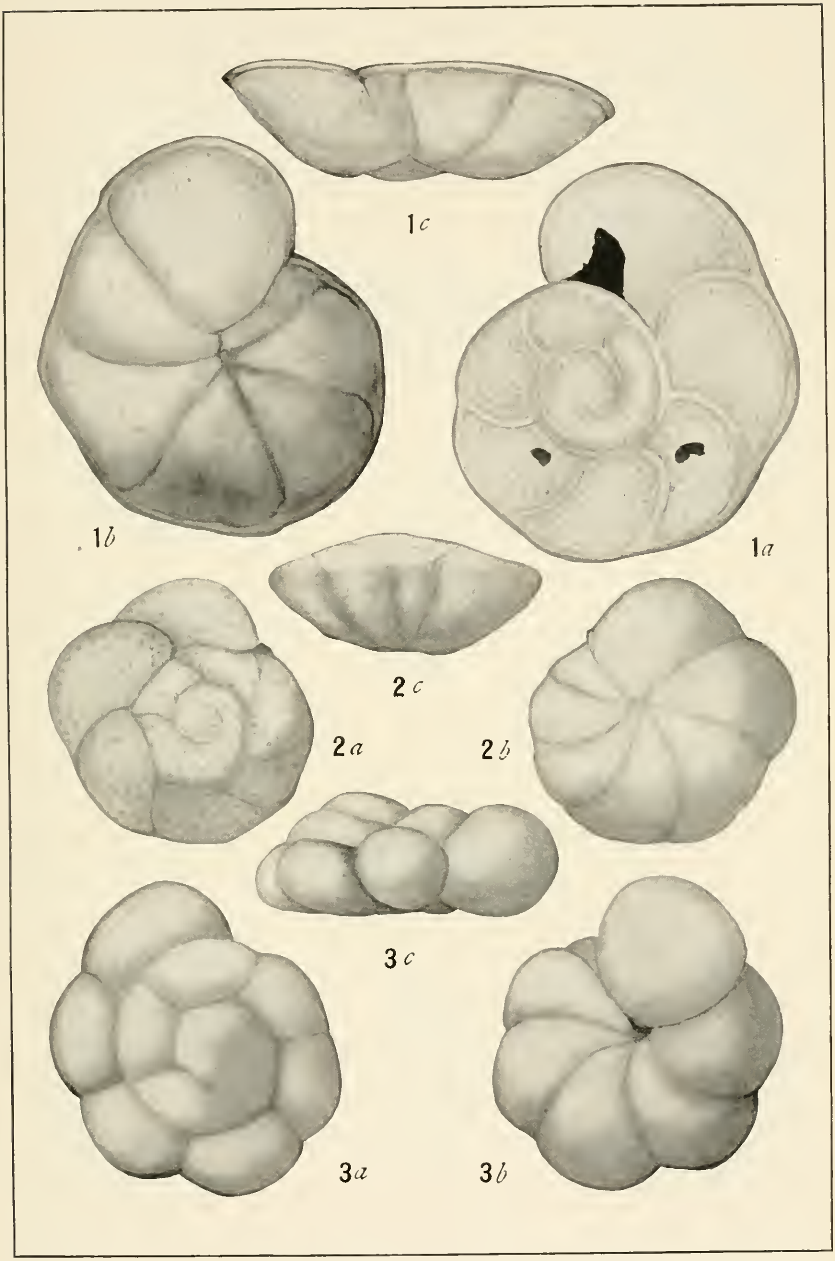
FOR EXPLANATION OF PLATE SEE PAGE 78.


1c
1b
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2c
2a
2b
3c
3a
3b

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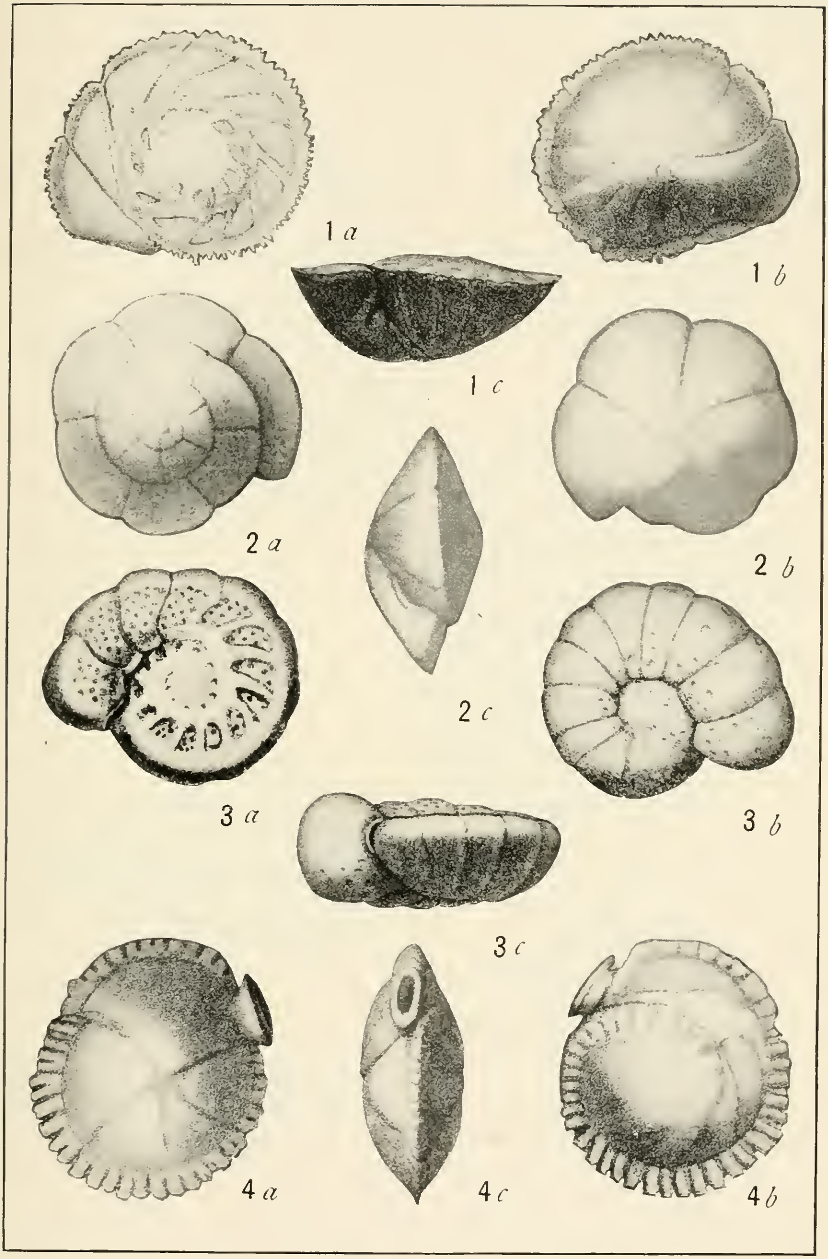
1 a
1 b
1 c
2 a
2 b
2 c
3 a
3 b
3 c
4 a
4 c
4 b

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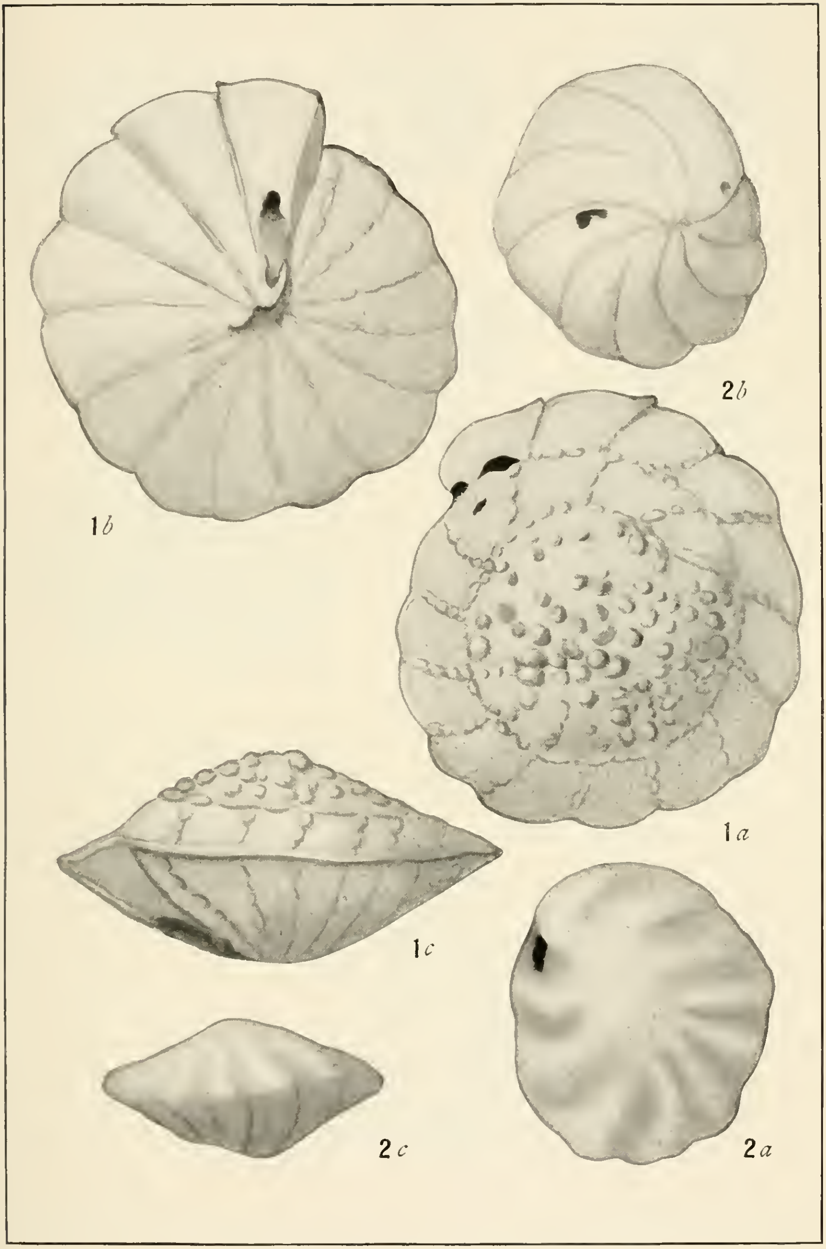
1*b*
2*b*
1*a*
1*c*
2*c*
2*a*

Rotaliidæ of North Pacific Ocean.

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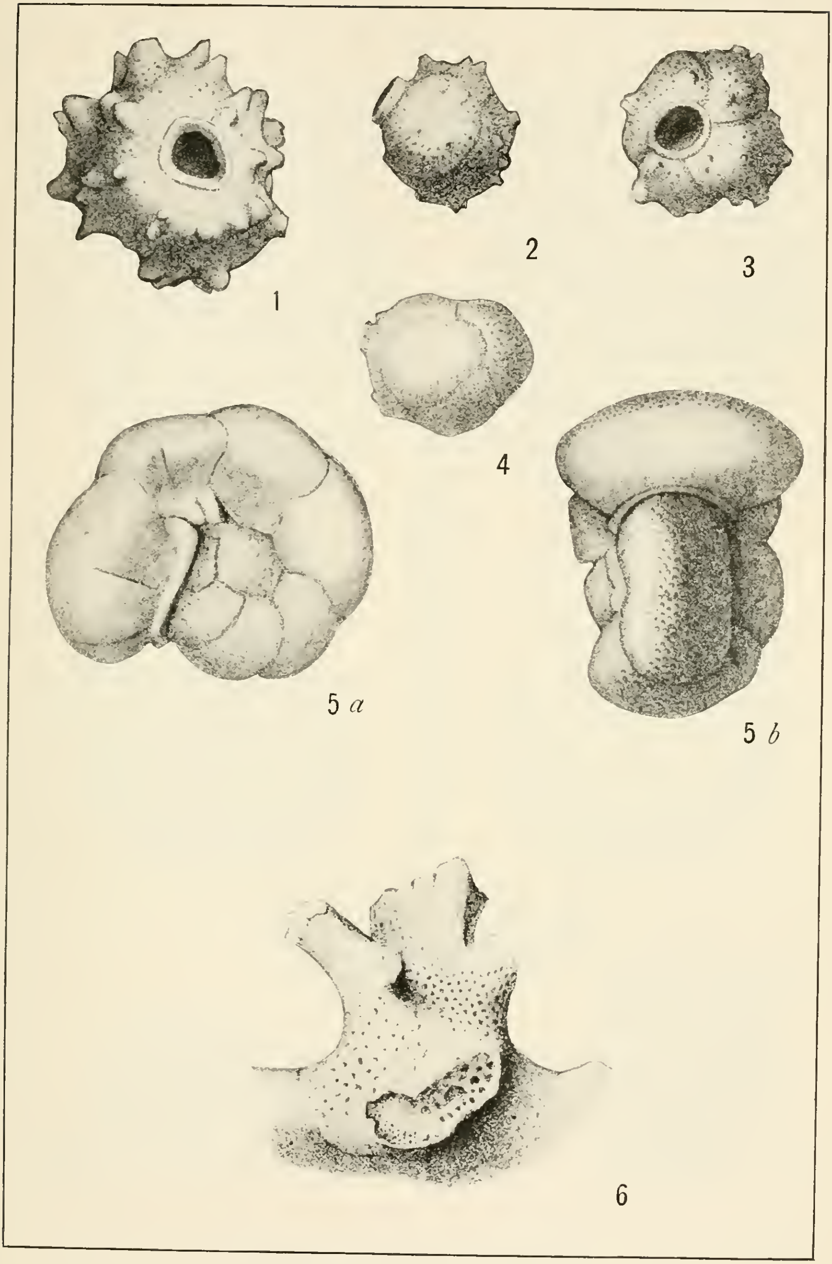

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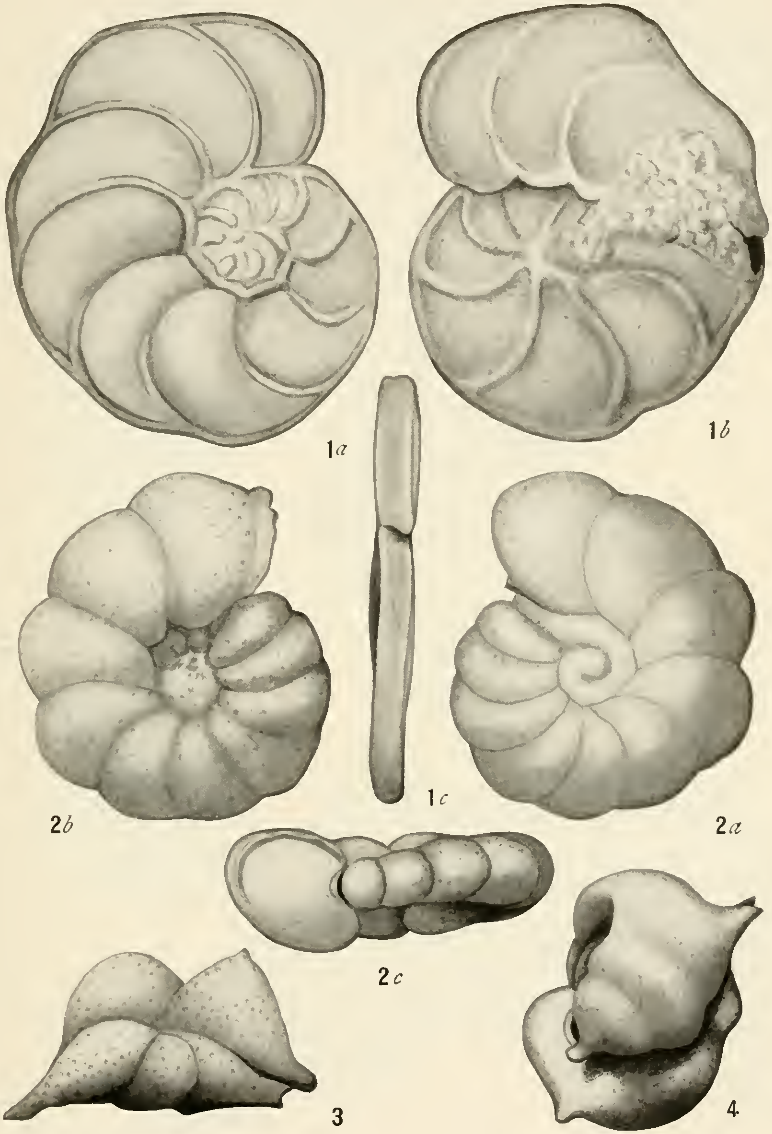
1a
1b
1c
2b
2a
2c
3
4

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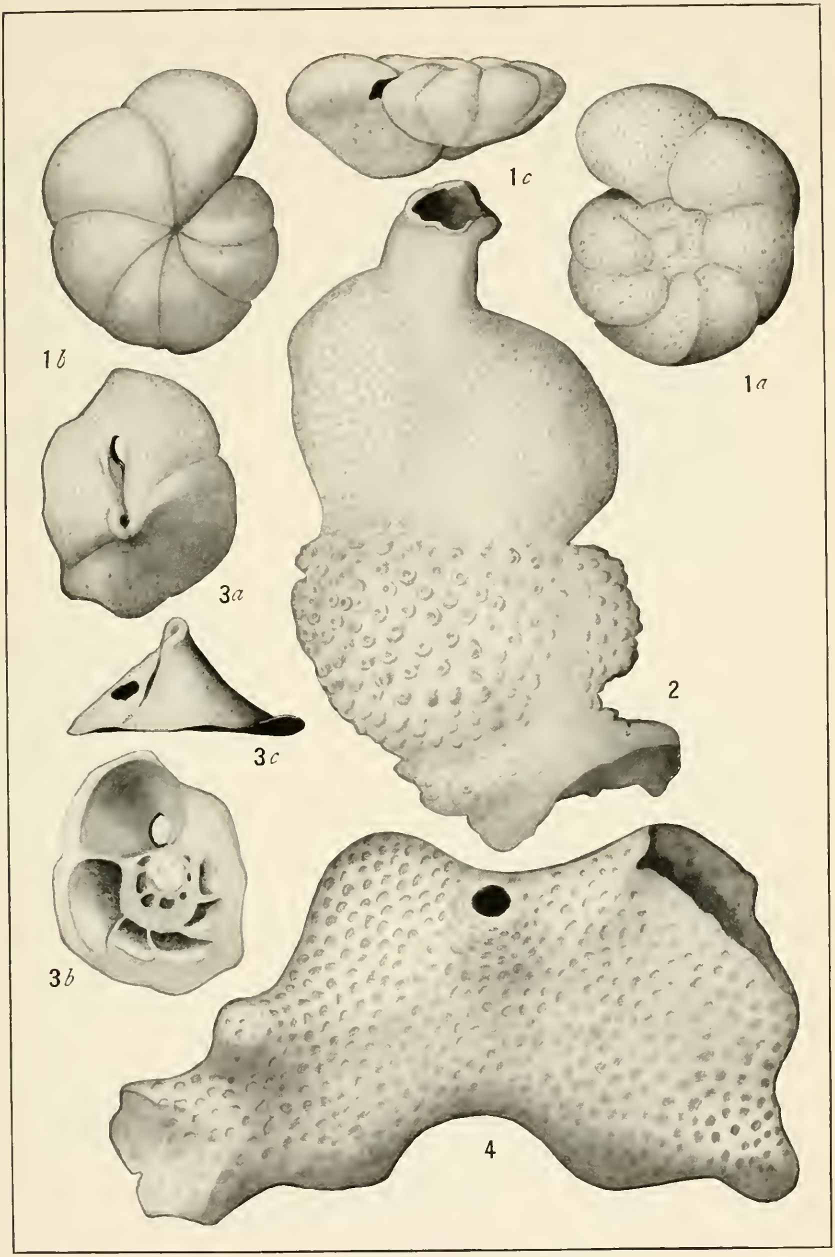
1c
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3a
3c
3b
4

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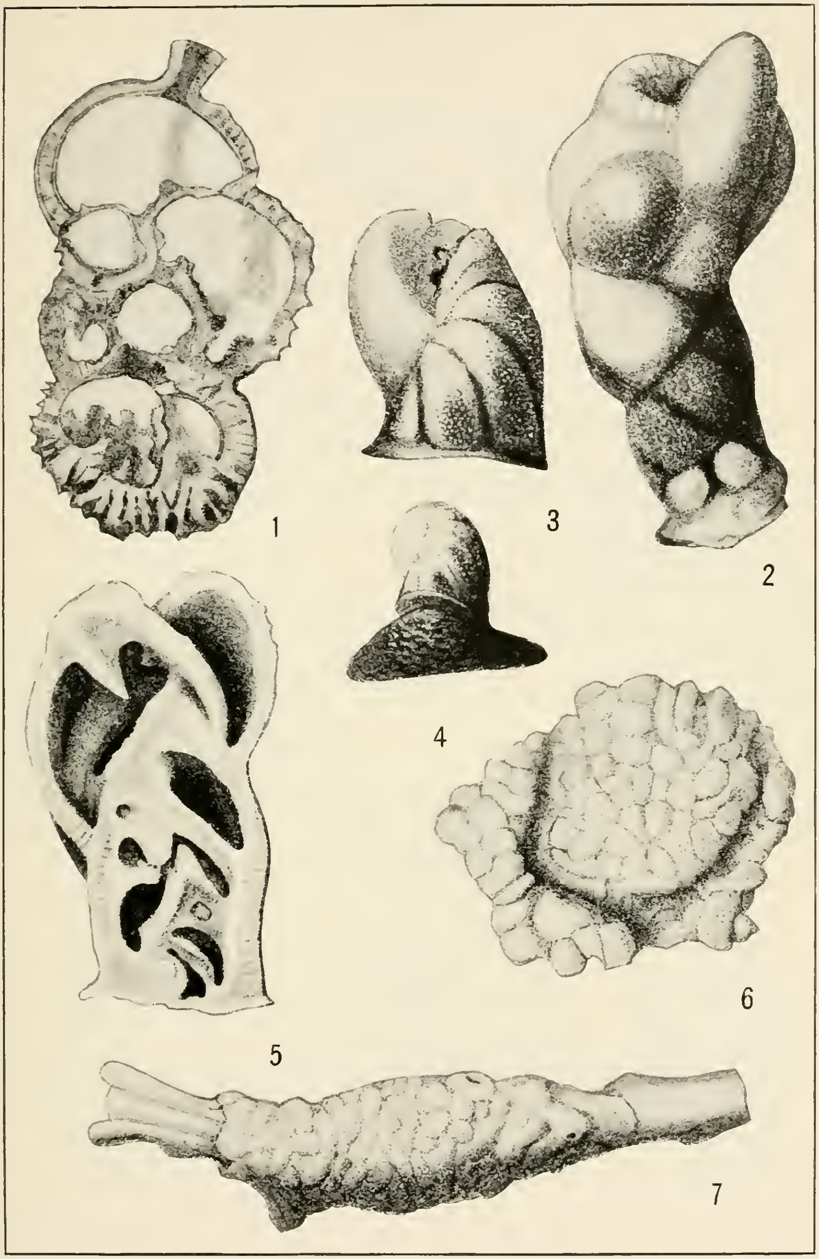

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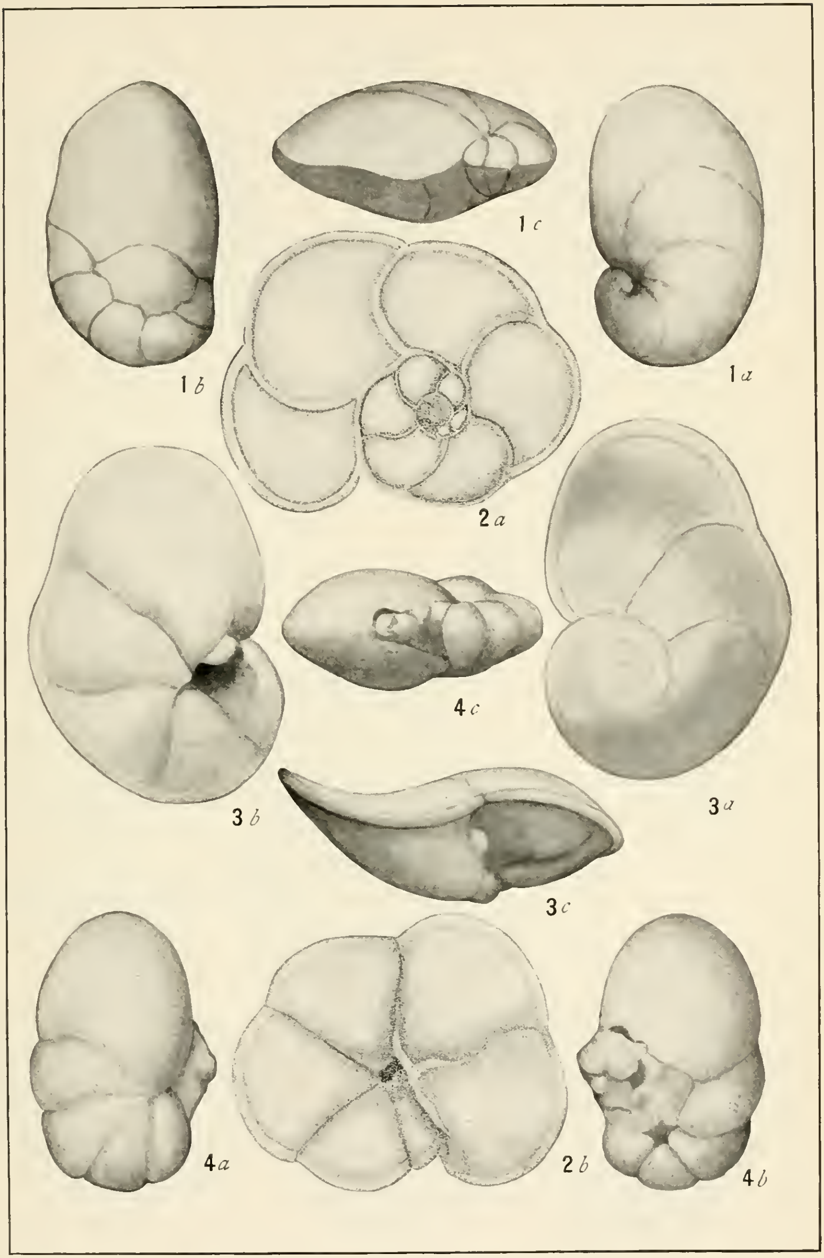
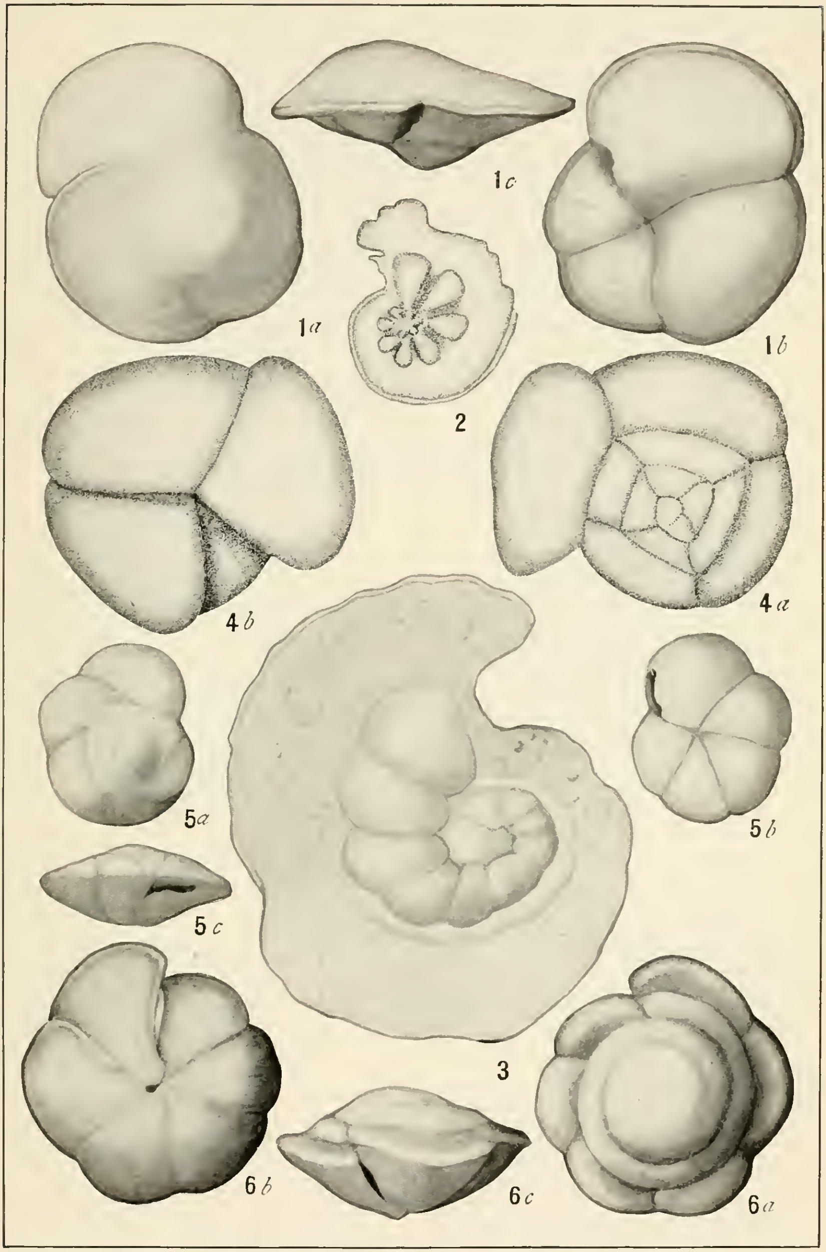

1 b
1 c
1 a
2 a
3 b
4 c
3 a
3 c
4 a
2 b
4 b

ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 80.


1c
1a
2
1b
4a
4b
5a
5b
3
5c
6b
6c
6a

Rotaliidæ of North Pacific Ocean.

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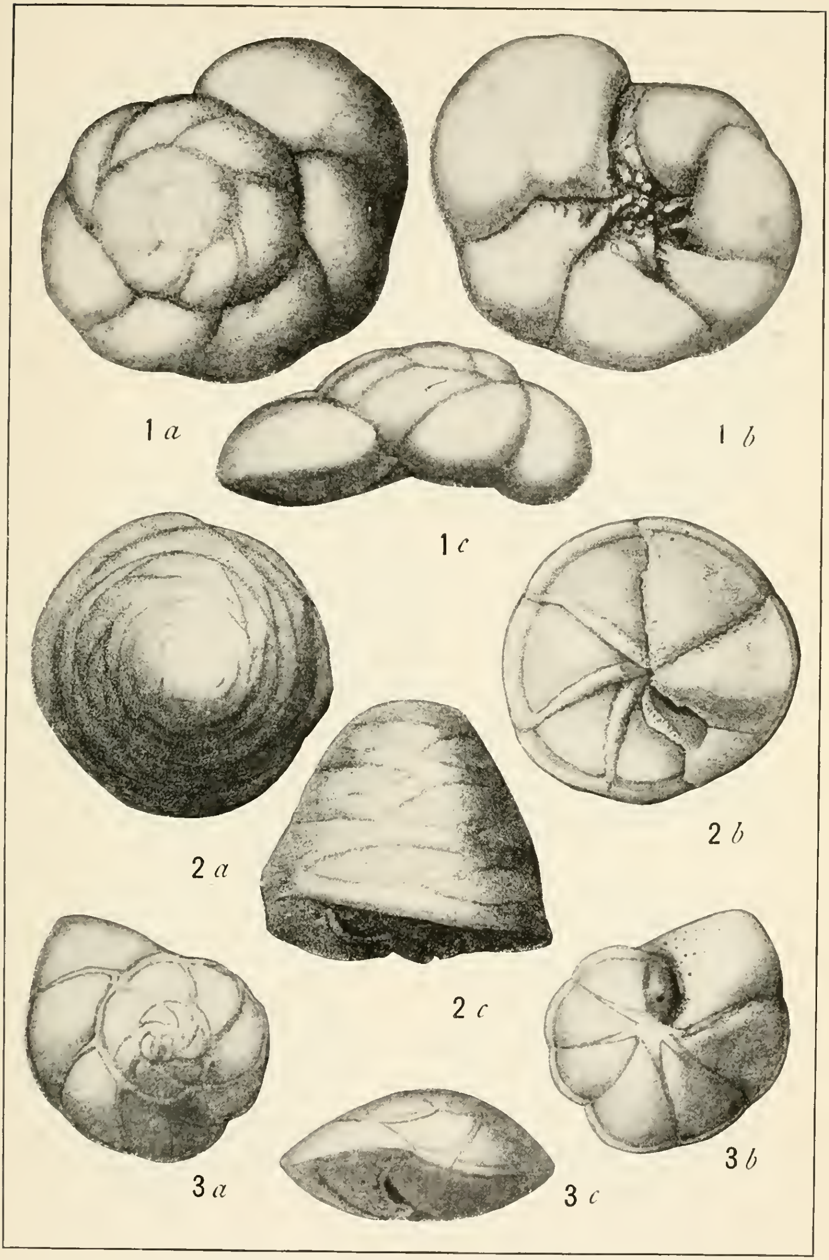
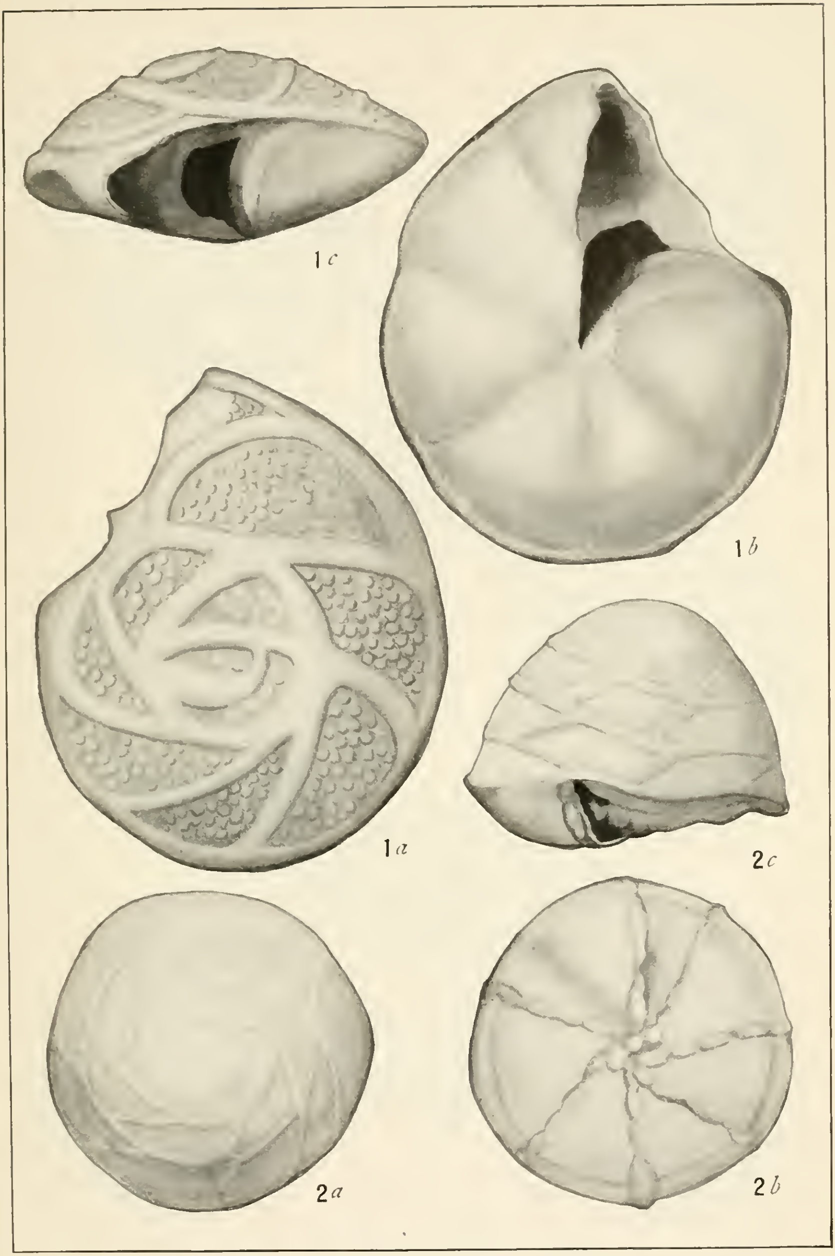

1 a
1 b
1 c
2 a
2 b
2 c
3 a
3 b
3 c

ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 80.


1c
1b
1a
2c
2a
2b

Rotaliidæ of North Pacific Ocean.

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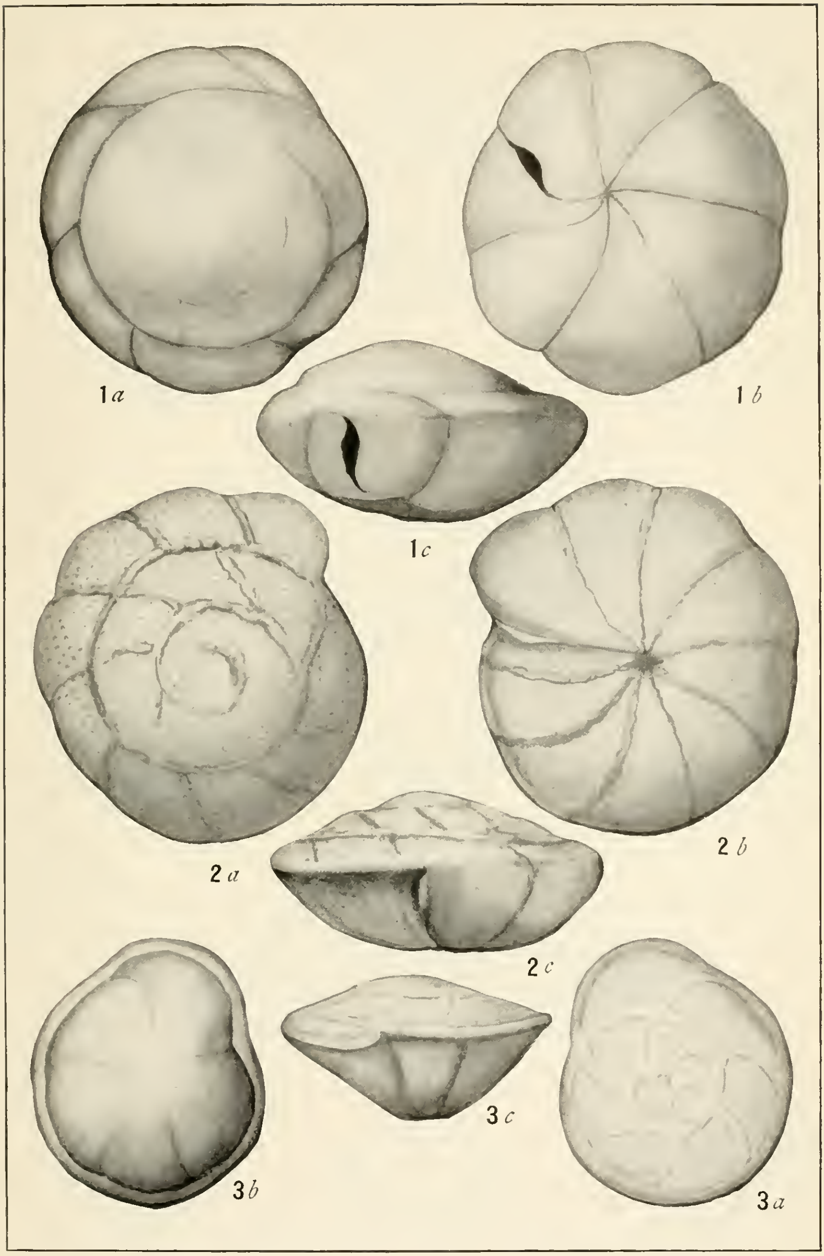
1*a*
1*b*
1*c*
2*a*
2*b*
2*c*
3*c*
3*b*
3*a*

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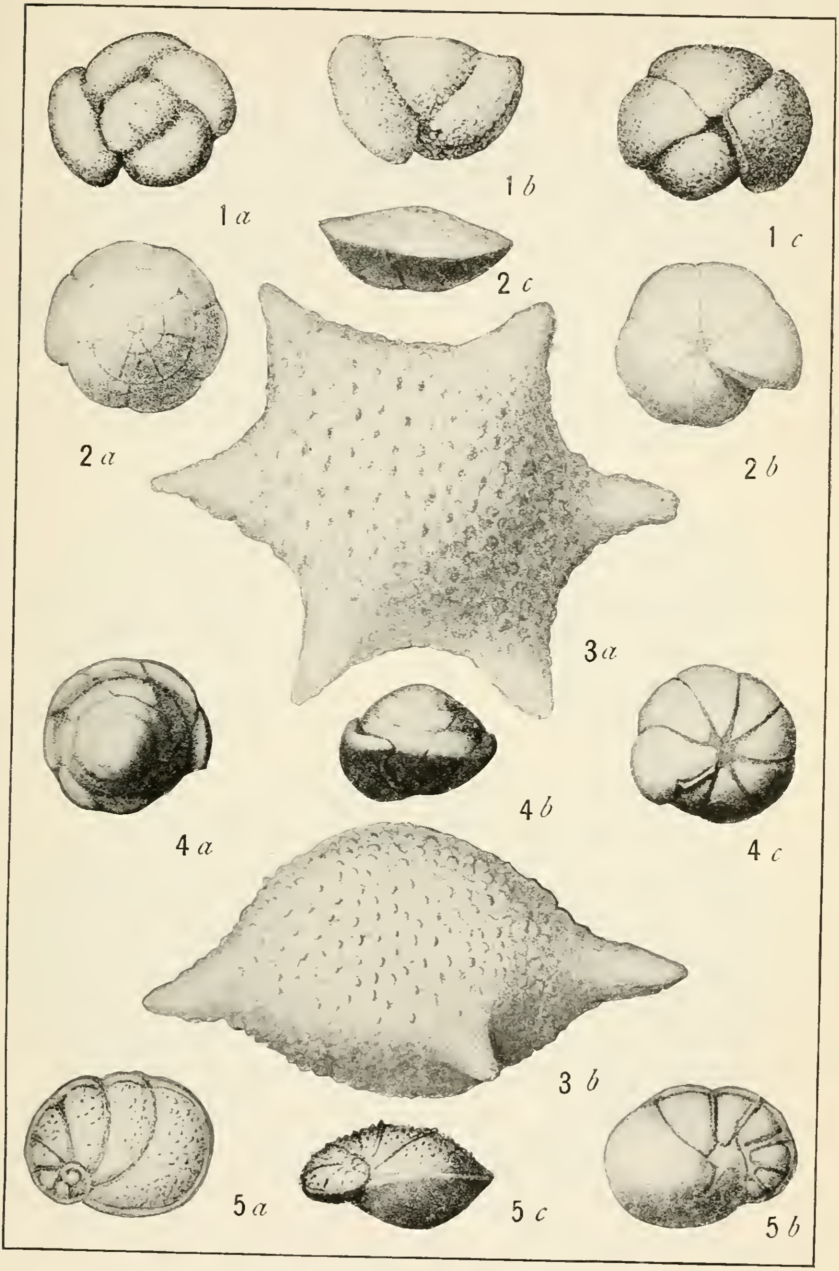
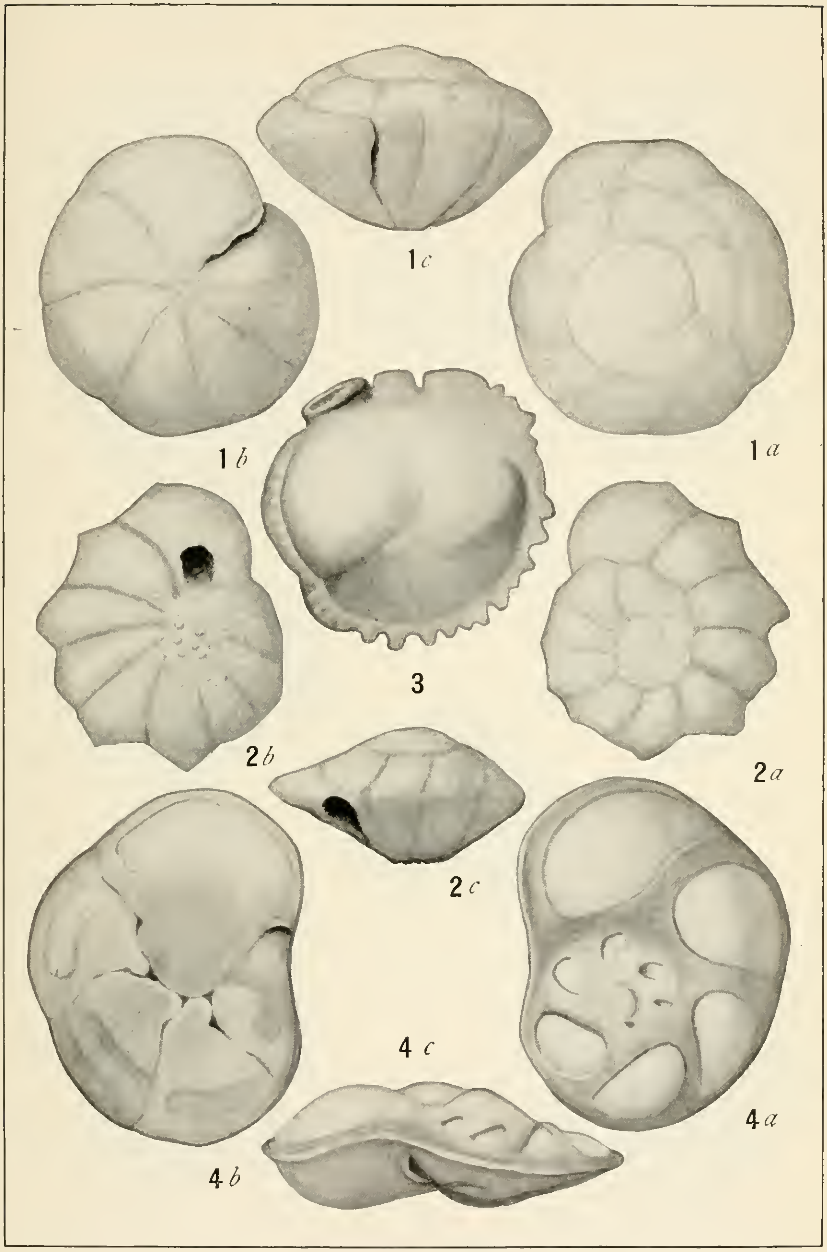

1 *a*
1 *b*
1 *c*
2 *a*
2 *b*
2 *c*
3 *a*
3 *b*
4 *a*
4 *b*
4 *c*
5 *a*
5 *b*
5 *c*

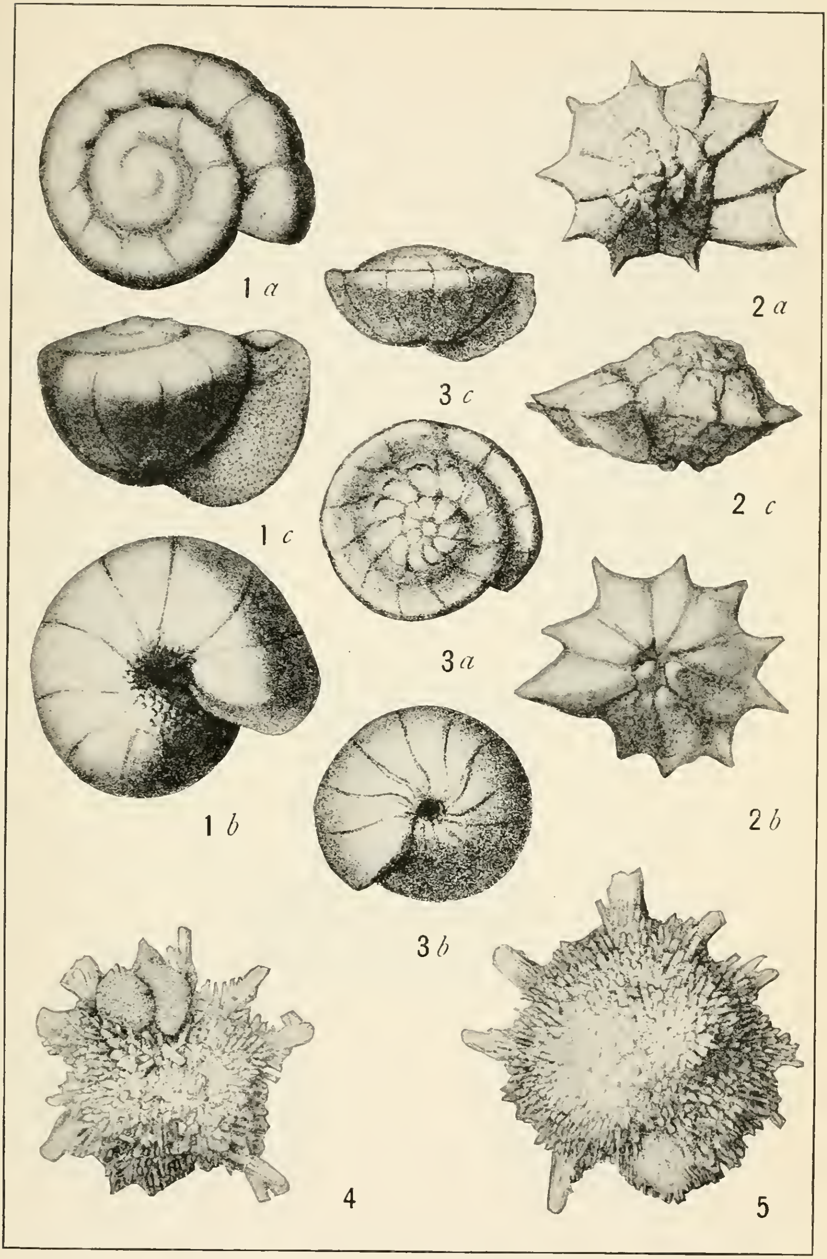
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 80.


1 c
1 b
1 a
3
2 b
2 a
2 c
4 c
4 a
4 b

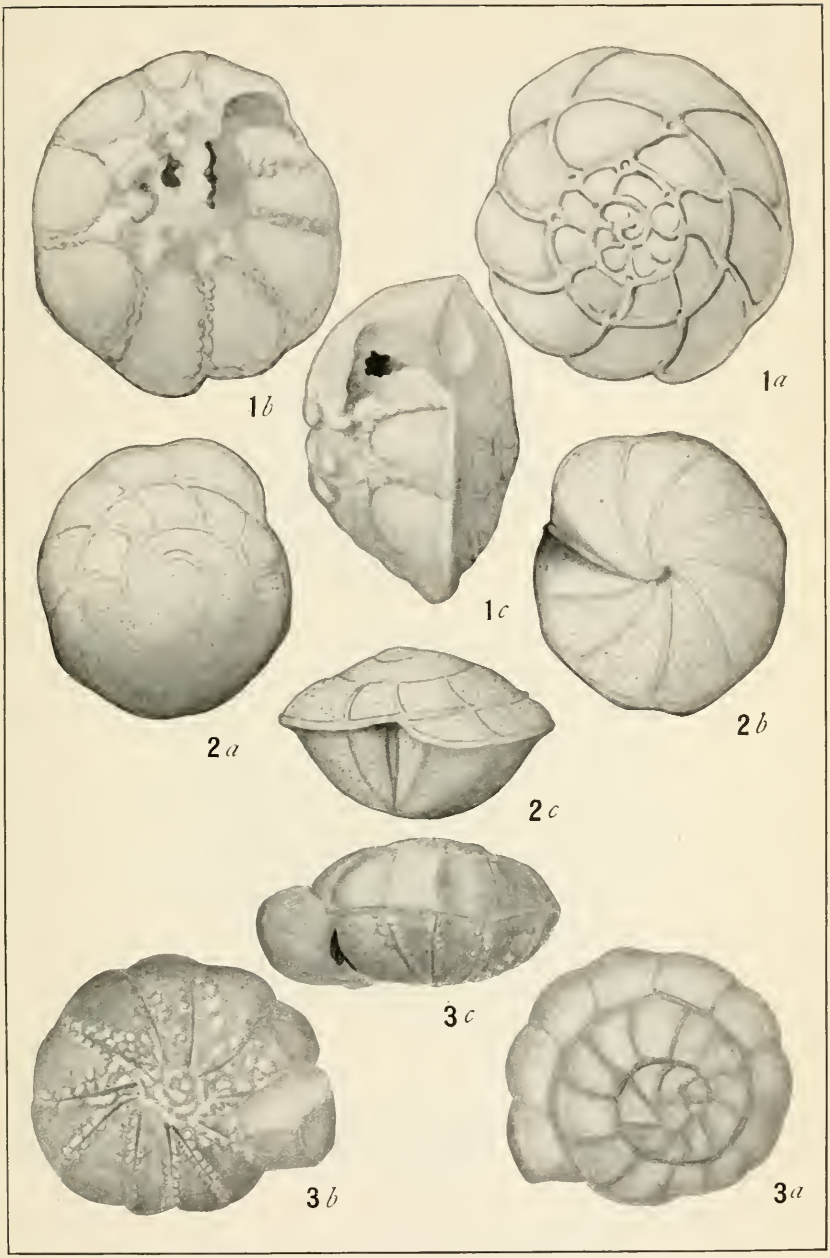
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 80.


1 *a*
3 *c*
2 *a*
1 *c*
2 *c*
3 *a*
1 *b*
2 *b*
3 *b*
4
5

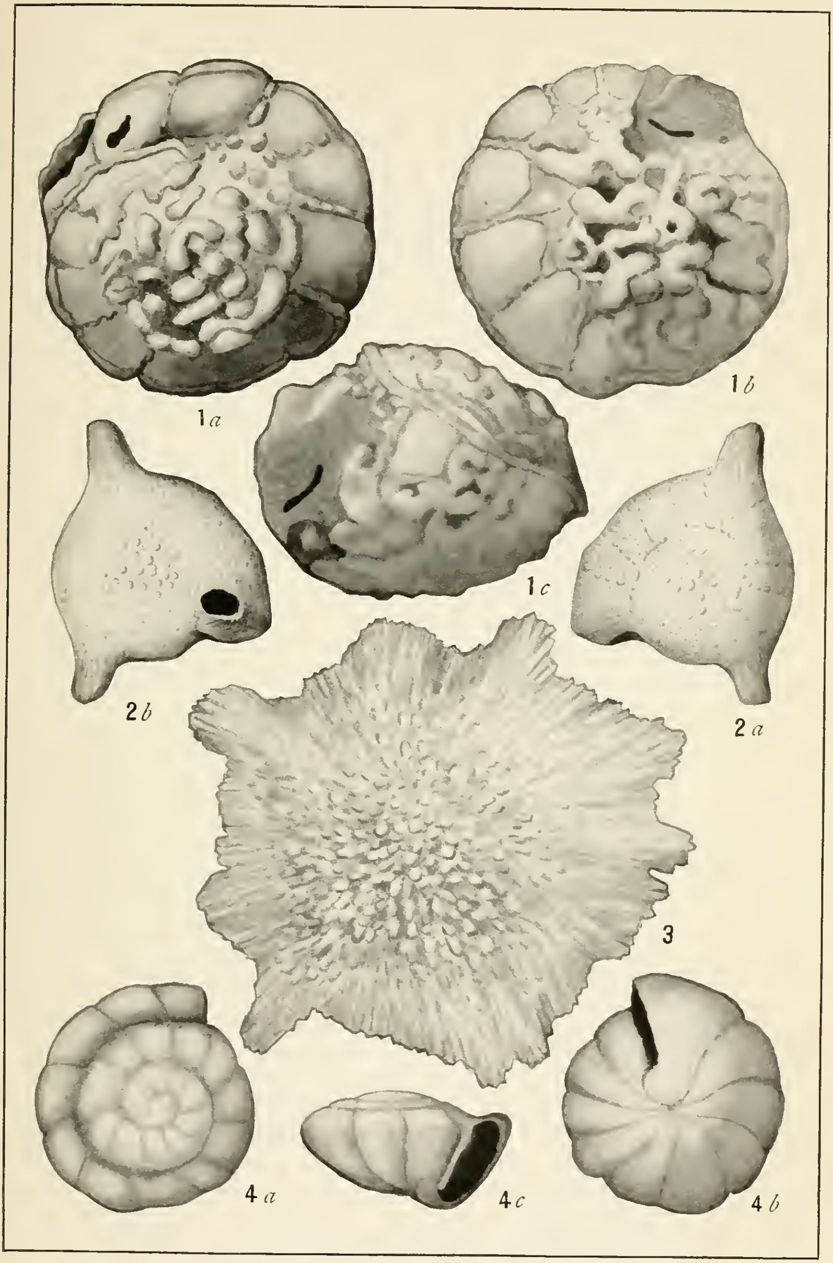
ROTALIIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGES 80, 81.


1b
1a
1c
2a
2b
2c
3c
3b
3a

Rotaliidæ of North Pacific Ocean.

For explanation of plate see page 81.


1a
1b
1c
2b
2a
3
4a
4c
4b

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN

PART VI. MILIOLIDAE

BY

JOSEPH AUGUSTINE CUSHMAN
Of the Boston Society of Natural History

WASHINGTON
GOVERNMENT PRINTING OFFICE
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INTRODUCTION.

The present volume is the sixth and last of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the family Miliolidae. The first part, issued in 1910, included the families Astrorhizidae and Lituolidae; the second part, issued in 1911, the family Textulariidae; the third part, issued in 1913, the family Lagenidae; the fourth part, issued in 1914, the families Chilostomellidae, Globigerinidae, and Nummulitidae; and the fifth part, issued in 1915, included the family Rotaliidae.

Joseph Augustine Cushman.

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

MILIOLIDAE.

By Joseph Augustine Cushman,

Of the Boston Society of Natural History.

INTRODUCTION.

This sixth and last part of the work on the North Pacific Foraminifera deals with the single family Miliolidae. By most writers this family has been considered as very primitive on account of its apparently having no pores in the test, but it has gradually been ascending in the scale. In the *Challenger* report it was the earliest family considered, but has since by many writers been placed above the arenaceous forms of the Astrorhizidae and Lituolidae.

The discovery by several workers that the earlier chambers of some of the highest genera of the family have a perforate test shows that it developed from a perforate ancestry. The geological history of the family is also rather conducive to the idea that it developed rather later than other relatively highly developed types as the Nummulitidae, where *Fusulina*, one of the complex types, was characteristic of the Carboniferous. The greatest development of the Miliolidae as far as number of species and complexity of structure are concerned seems to have been the late Cretaceous and early Tertiary.

The present paper does not contain as many species as would be the case were the present collections better represented by shallow-water material, especially about the tropical islands of the area.

PHYLOGENETIC DEVELOPMENT OF THE MILIOLIDAE.

To d'Orbigny must be given the credit for the first critical study of the foraminifera belonging to the Miliolidae. Previous authors had described and named certain of the species, but very little attempt had been made to determine the relationships of the various forms. In his work in 1826 d'Orbigny [1] recognized many of the still accepted generic characters and to a certain extent their relationships. Under the Foraminifères, Order Agathistegnes, d'Orbigny grouped the genera *Biloculina*, *Spiroloculina*, *Triloculina*, *Articulina*, *Quinqueloculina*, and *Adelosina*, all genera which he described.

---

[1] Tableau méthodique de la classe des Cephalopodes, Ann. Sci. Nat., vol. 7 1826, p. 245, etc.

Perhaps d'Orbigny's most important contribution was the recognizing of the relative position of the chambers and the consequent number visible from the exterior. The chamber arrangement, very definitely described and figured by d'Orbigny, was not in some cases later recognized by subsequent authors as of generic importance.

By the early English group of workers on the Foraminifera, Carpenter, Parker, Jones, and Brady, the genus *Miliolina* was taken to include *Triloculina* and *Quinqueloculina* as well as certain other genera. These two genera mentioned were not understood as described by d'Orbigny, as may be seen by Carpenter's figures of *Quinqueloculina*, which are really copies of Parker's figures in an earlier paper.[1]

Parker's ideal transverse sections (on p. 57, fig. 5, *a*, *b*, and *c*) do not represent *Quinqueloculina* as described by d'Orbigny. Moreover the various genera and their different characters were only recognized by Carpenter and others as pure variations. The fact that these animals were unicellular has in the minds of many workers on the Foraminifera presupposed an unlimited amount of variation and the explanation of nearly all different characters on this basis. The larger work of Carpenter, Parker, and Jones, Introduction to the Study of the Foraminifera, 1862, helped greatly to fix this idea of unlimited variation and the supposed lack of any definite characters. An example of the extreme view of Carpenter is shown in his introduction (p vii) in the following words: "*Sharply defined divisions*—whether between species, genera, families, or orders—*do not exist among Foraminifera.*"

Brady in the *Challenger* report and elsewhere breaks away somewhat from the extreme of these views in that he describes new species and genera, but he is plainly influenced by the work of Carpenter and tries to unite various forms on the basis of variation rather than seeking the true explanation of their differences. Brady figures sections of some of the Miliolidae, but the important early chambers are usually indistinct and he makes little reference to them.

Goës [2] adopted early adopted extreme views of variability in the Foraminifera and the uselessness of distinguishing more than a few central species about which the others should be grouped as variants. As an example of his extreme views at this time, he includes under the genus *Miliola* three species, the first of which, *M. seminulum* (Linnaeus), he divides into six varieties. Under this species Goës includes as synonyms more than a hundred specific names and five of the genera of d'Orbigny. The second species includes species usually assigned to *Biloculina*, and the third species those belonging to *Spiroloculina*. Thus Goës includes seven of the genera of d'Orbigny under *Miliola*, and extreme view not taken by even the most radical of the British group of workers along this line.

---

[1] On the Miliolitidae (Agathistègnes d'Orbigny) of the East Indian Seas, Part I, Miliola, Ann. Mag. Nat. Hist., ser. 2, vol. 6, 1858, p. 53, etc.

[2] On the Reticularian Rhizopoda of the Caribbean Sea, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882.

Twelve years later in another paper[1] Goës shows a decided change in attitude. The genera *Biloculina* and *Spiroloculina* are recognized, and *Miliola* contains the other genera. Instead of grouping all under three species, Goës allows 37 species, variously grouped as subspecies and species and describes four new species. Two years later in still another paper[2] Goës recognized also the genus *Sigmoilina* of Schlumberger in addition to those recognized in 1894. One new species of the Miliolidae is described. In this paper, besides Miliolidae, Goës describes over 20 new species and varieties, as well as some new genera. In this last paper, and especially the preceding one, many excellent sections of Miliolidae are figured, showing the stages in development, but little use is made of them.

To Munier-Chalmas and Schlumberger, especially to the latter, must be given credit for the elucidation of the real structure of many of the generic types of the Miliolidae. Their researches are based upon painstaking work in sectioning great numbers of specimens, both fossil and recent, belonging to this family. Their work was, in the main, the search for and demonstration of the two forms, microspheric and megalospheric, in the various species and the basing of generic characters upon definite morphological structure. The immature characters are not as fully dwelt upon as probably would have been done had Schlumberger lived to continue his work. The many new genera Schlumberger described have basis in structure and developmental characters and are restored to their rightful value, although modified somewhat by certain later views as to their scope. Altogether the work of Schlumberger is the most valuable work of any student of the Miliolidae as regards the demonstration of Dimorphism (used in the sense of the two distinct generations) in many species and the early stages in the development of various generic types.

Rhumbler has studied especially the *Peneroplis* group and the peculiar double forms of *Orbitolites*. He demonstrated the perforate character of the proloculum of *Peneroplis*.

Lister has worked mainly with the *Peneroplis* group, *Peneroplis*, *Orbiculina*, and *Orbitolites*, as far as the Miliolidae are concerned. He demonstrated the perforate character in the proloculum of the last two genera and has done much work on the dimorphism of various species.

---

[1] A Synopsis of the Arctic and Scandinavian Recent Marine Foraminifera, Kongl. Svensk. Vet.-Akad. Handl., vol. 25, No. 9, 1894.

[2] On the Foraminifera of the Galapagos Islands, etc., Bull. Mus. Comp. Zoöl., vol. 29, No. 1, 1896,.

Chapman has demonstrated the two forms of *Alveolina*, and the series of these larger forms is now nearly complete.

To Lister and Schaudinn we owe much of the knowledge of the life history of the Foraminifera and the relation of dimorphism to the life cycle. Many other investigators have added, in greater or lesser degree, to our knowledge of the Foraminifera, but the names noted above stand out prominently in the history of the work in the development of the Miliolidae.

Proloculum.—The proloculum or initial chamber of the Foraminifera as seen in the Miliolidae consists of an oval or subspherical chamber. The test of the proloculum in some genera (*Peneroplis*, *Orbiculina*, and *Orbitolites*) is clearly perforate, while this character has not been made out in other genera.

The proloculum is the first distinct stage in the development of the test. Although in the Miliolidae there is no distinctly single chambered form which may be considered as the radicle (like *Lagena* for the family of the Lagenidae), it is fair to assume that there was in the early development of the group a single-chambered form. This radicle, although not definitely known as an adult, is represented by the proloculum or first stage in the development of the many chambered forms of the family. The size of the proloculum is of great importance, as will be considered in later discussion.

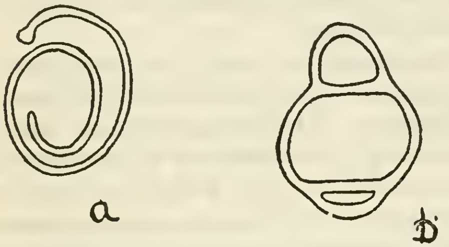


Fig. 1.—"Embryonic young" of Miliolidae, in this case of Peneroplis, taken from the "mother test." (After Schacko × 420.) *a*, Longitudinal section showing the proloculum, oval in shape followed by the long cornuspira-like second chamber; the wall of the two continuous and of the same thickness. *b*, Transverse section showing the second chamber at the two sides of the proloculum, the uniform single wall and the flattening of the sides of the proloculum where the second chamber impinges upon it, an added proof that the two are formed at the same time.

Characters of the "embryonic" young of Miliolidae.—The production of young in a number of genera of the Miliolidae has been noted by several observers. The young individuals are formed inside the chambers of the adult test, especially in the outer and larger chambers. The characters throughout the family in this "embryonic" stage seem to be very uniform. A detailed description of this stage in the development will be useful for later comparison.

The young individual (fig. 1) when set free from the "mother" cell consists of two distinct stages in its test characters. The first chamber is a globose proloculum in all normal individuals. Exceptions to this condition will be noted later. The second chamber consists of a nonseptate tube close coiled about the proloculum. Seen from the side (fig. 1*a*) the width of the tube increases from its inception until the broadest part is developed near the distal end. Seen in vertical view this tube has a nearly uniform width. In cross section (fig. 1*b*) the various parts of the tube are seen to have a considerable difference in height. The proximal portion is low and flattened, the side adjacent to the proloculum being nearly flat, the outer side convex. The height of the tube increases from this point toward the distal end, where its height may equal the width. The aperture is contracted and considerably smaller than the diameter of the tube. The length of this second chamber is rather constant, being usually between a half and a complete coil.

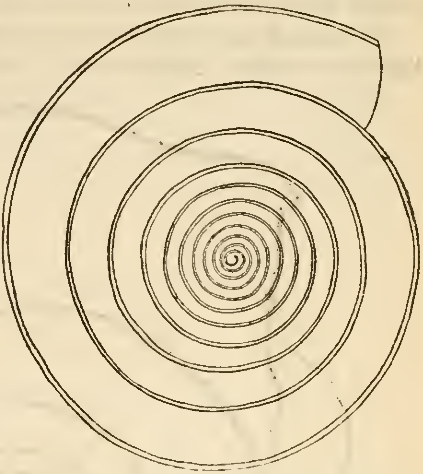


Fig. 2.—Cornuspira involvens Reuss. × 63. Microspheric specimen viewed by transmitted light. Specimen with very small proloculum, but with its numerous coils growing to a much larger size than the megalospheric form with its much larger proloculum and fewer coils (fig. 3).

Another character of especial importance when comparison is made with the early chambers of adult tests is that of the wall. The wall which forms the common boundary between the proloculum and the second chamber is, as far as can be determined, a single wall, no new shell substance apparently being laid down by the animal on the floor of the tubular chamber. As a result of the walls of the test in its "embryonic" stage are single and of practically uniform thickness. The only exception is the thickening which appears at the aperture of the second chamber. This foreshadows the thickened lip seen in so many of the genera in this family.

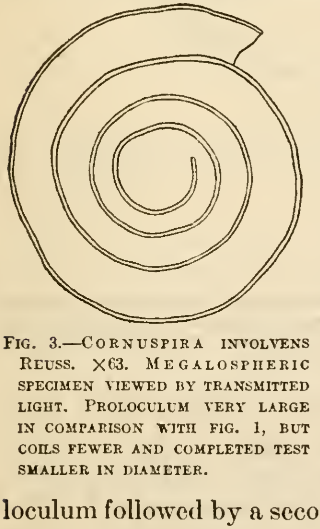


Fig. 3.—Cornuspira involvens Reuss. ×63. Megalospheric specimen viewed by transmitted light. Proloculum very large in comparison with fig. 1, but coils fewer and completed test smaller in diameter.

Development of Cornuspira.—In *Cornuspira*, which is the simplest of any of the family in its development (possibly excepting *Squamulina* or *Nubecularia*, which are degenerate forms), has in reality nothing in addition to the developmental characters seen in "embryonic" young already described. It has a globular or ovoid proloculum followed by a second chamber of indefinite length built on the outside of the previous portion of the test in a planospiral manner without building a floor as it proceeds. It differs from the embryonic young only in the length of this second chamber and its various modifications of ornamentation and relative proportions which constitute the specific characters in the various species of *Cornuspira*.

Occasional specimens show a reduction in the size of the tube in the last formed portion as in senescence in some Mollusca. In others there is a tendency which may be considered rather more prophetic in its nature. In the specimen figured here in outline (fig. 4) is shown a recent specimen which upon first examination seemed to have no characters unlike typical specimens and it was selected for mounting in balsam for a study of the early coils. After mounting examination showed a partial division into chambers

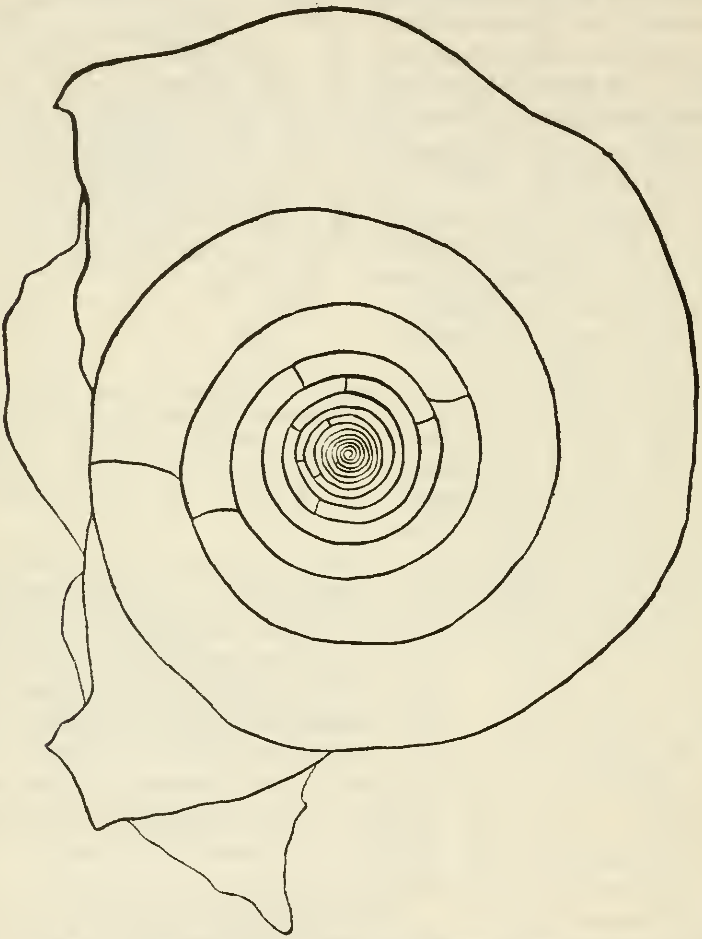


FIG 4.—CORNUSPIRA FOLIACEA (PHILIPPI). ×24. COMPLETE SPECIMEN, THE YOUNG OF WHICH IS SHOWN IN FIG. 5. SPECIMEN SHOWS THE LATER "PARTITIONS" DEVELOPED IN THE LARGER, OUTER COILS OF THE TEST. THE LAST FORMED CHAMBER WAS PARTIALLY BROKEN WHEN FOUND. VIEWED BY TRANSMITTED LIGHT.

instead of the usual nonseptate condition. In all, 12 partitions were made out. After the proloculum (fig. 5) there are three complete coils of nonseptate tube, as in ordinary specimens. Then the tube is cut off by a "partition." Following this are three and three-quarters coils of nonseptate tube and then another "partition." About a quarter coil beyond is a third "partition," then in each succeeding coil a "partition" is found when a coil has been nearly completed. Again, there is a quarter coil followed by a "partition." From this point there are six "partitions" in the following five coils, without any definite arrangement. A figure shows the arrangement in the earlier chambers (fig. 5).

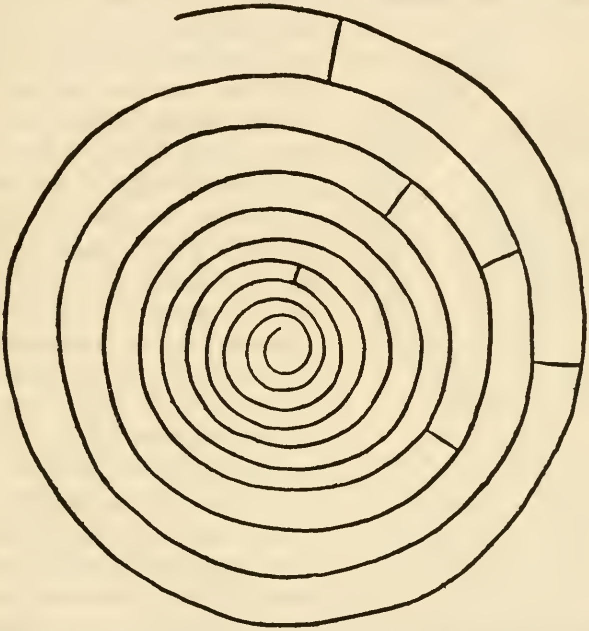


Fig. 5.—Cornuspira foliacea (Philippi). × 116. Early coils of microspheric specimen showing the "partitions" developed at irregular intervals in the tubular chamber. Viewed by transmitted light.

Both microspheric and megalospheric specimens occur in various species of the genus. A megalospheric (fig. 3) and microspheric specimen (fig. 2) of *Cornuspira involvens* are here shown in the same magnification. The number of coils in general is in inverse ratio to the size of the proloculum in the two, but, as is usually the rule in the foraminifera, the microspheric form attains the greater size.

Development of Opthalmidium.—The developmental stages of *Opthalmidium inconstans* H. B. Brady may be taken as showing the general characters of the genus. In this species (fig. 6) there is the usual oval proloculum (1), followed by a closely coiled tubular chamber (2); the second chamber may be directly compared to *Cornuspira*, and at this stage *Opthalmidium* has completed the developmental characters of an adult *Cornuspira*. The third chamber (3) introduces several new characters. The first of these is seen in the length of the chamber, which is between two-thirds and three-fourths of a single coil. This characteristic chamber, while seen as a definite stage in this genus, has not been noted as an adult character in any known genus. With this characteristic length of chamber comes another character seen in the tendency to lose the close-coiled condition at the distal end of the chamber. Near the aperture the chamber leaves the preceding chamber and takes a tangential direction, thus standing out from the original direction of coiling. The fourth chamber (4) has the same characteristic length in most cases becoming a little nearer the two-thirds of a coil, being slightly shorter than the preceding, chamber 3. Toward its aperture it also tends to take a tangential direction, so that its apertural portion stands free from the preceding coils. At its beginning this chamber starts at some distance from the inner coils due to the separation of the apertural portion of the preceding chamber (3) from the rest of the test. As a result there is a space left which is filled in by a thin plate like portion of shell. A similar filling is seen where chamber 5 starts its growth. These more or less triangular areas are shown by the smaller dotted areas of the figure. Chamber 4 also adds another really specific character, that of building a peripheral winglike shell growth about its own outer wall. Thus chamber 4 introduces the specific character of a peripheral wing, although the true generic characters are not yet attained.

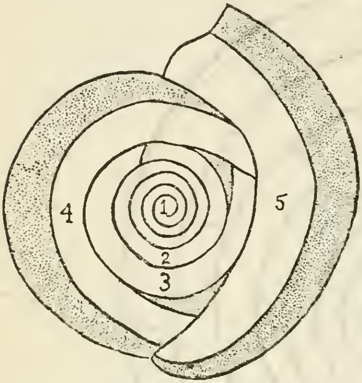


FIG. 6.—OPTHALMIDIUM INCONSTANS H. B. BRADY. × 65 (ADAPTED FROM BRADY). YOUNG SPECIMEN VIEWED BY TRANSMITTED LIGHT, SHOWING (1) PROLOCULUM, FOLLOWED BY (2) A LONG CORNUSPIRALIKE SECOND CHAMBER, THREE AND ONE-HALF COILS IN LENGTH, (3 AND 4) CHAMBERS THREE-FOURTHS TO TWO-THIRDS OF A COIL IN LENGTH AND (5) THE FIRST ADULT CHAMBER ONE-HALF OF A COIL IN LENGTH. DOTTED PORTION SHOWS THE FLANGELIKE CARINA.

Chamber 5 initiates the adult characters as far as the genus is concerned. This consists of a chamber making a half coil. In this particular species it also loses the character of uncoiling at its apertural end but has the wing-like growth on its own periphery. Following chambers keep to the character of developing a half coil and aclose coiled condition throughout.

In general the genus *Opthalmidium* has the following development a proloculum, followed by a close-coiled *Cornuspira* chamber of two or more coils in length, in turn followed by a series of chambers in general about two-thirds of a coil in length and tending to uncoil at their apertural ends, the space thus left being filled in by shell growth as the following chamber is built, the adult character being a series of chambers close coiled and one-half a coil in length.

Development of Planispirina.—*Planispirina* is a genus not greatly removed in some respects from *Cornuspira* and *Opthalmidium.* The species *P. exigua* H. B. Brady will serve to show the development. Figure 7 shows a specimen viewed by transmitted light. There is a globose proloculum followed by a very long *Cornuspira*-like second chamber consisting of two and a half coils of continuous tube. In this long second chamber there is a relatively primitive development compared to that seen in the second chamber of *Opthalmidium.* The third chamber makes a half revolution as does also the fourth. This condition is much like that seen in *Spiroloculina* or in later stages of *Opthalmidium.* *Planispirina* differs from the young of *Spiroloculina* in its relatively less accelerated second chamber and also in its adult characters. It differs from the young of *Opthalmidium* in skipping the stage having chambers two-thirds of a coil in length, a stage intermediate between the long chambers of the early stages and the half coil chambers of the adult in *Opthalmidium.* The fifth chamber is shorter than the preceding ones, in this specimen being about a third of a coil in length. The sixth and seventh chambers complete the coil begun by the fifth chamber and give the adult character, that of a test with three or four chambers in each volution.

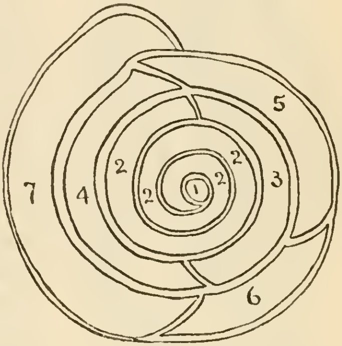


Fig. 7.—Planispirina exigua H. B. Brady. (Adapted from Brady.) Long second cornuspiralike chamber Proloculum (1). (2) followed by half coil length (chambers 3, 4) and later byone-third coil length(chambers 5–7).

From the exterior the chambers of the last coil are clearly visible, but those of the interior are hidden, as there are no definite markings on the surface to indicate the chambers.

Development of Spiroloculina.—The genus *Spiroloculina* is much more abundant in number of species and individuals in the Eocene deposits of France than it is in the present ocean. It reached a high development in the Eocene and a number of senescent forms are seen in those formations, more than in the recent species which are comparatively few and simple. *Spiroloculina* differs from its nearer allies, mainly in its open coil, there being little if any covering of the preceding whorls by involution. As a result the development is easily studied.

The development of *Spiroloculina bicarinata* d'Orbigny from the Eocene of the Paris Basin of Vandancourt may be taken as typical of an Eocene *Spiroloculina* (fig. 8). The first chamber consists of a globose proloculum. The second is the ordinary close-coiled, tubular, *Cornuspira*-like chamber with no floor as seen throughout the group. In this case its length is a little more than a half coil. The shell wall of these two chambers is thin and of uniform thickness as in the other genera already described. The third chamber at its inception is more than twice as high as the aperture of the preceding one, but gradually diminishes in height until at its own aperture it is hardly, if at all, higher than the aperture of the preceding chamber. In length it is a little more than a complete coil. It initiates two distinctive features of the genus. One of these is the tendency of the distal portion of the chamber to break away from the close-coiled condition and to change the axis of the chamber to a tangential position. As a result, a tubular neck is formed which is a rather general character among the Eocene species of *Spiroloculina*. Another character which is initiated here is the broad flaring lip at the aperture. This is also characteristic of a majority of the species of this period. This third chamber, therefore, initiates several important characters, but not the one of prime generic importance, the half coil length of chambers in a single plane. Beginning with the fourth chamber the specimen is at once definitely a *Spiroloculina*. The fifth and succeeding chambers simply add to the size of the individual or to the specific characters, no generic characters having been attained in the fourth chamber.

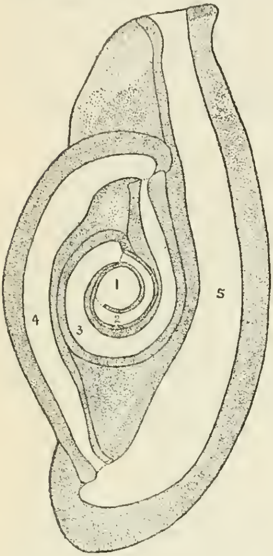


Fig. 8.—Spiroloculina bicarinata d'Orbigny. ×85. Eocene of Vandancourt, Paris Basin. Specimen viewed by transmitted light. (1) Proloculum, (2) second cornuspiralike chamber, (3) elongated chamber, (4, 5) adult chambers a half coil in length.

As the apertural lip when formed extends beyond the rest of the test, the space thus left is filled in before the next chamber is built. This is shown in the specimen figured, which was apparently about to form a new chamber. This shelly growth which is filled in is usually less solid than the rest and may appear of a lighter color when examined as a balsam mount with transmitted light. In some species such as *S. perforata* this space is left open and the new chamber is built without filling in the intermediate space between the neck and the body of the test. On the basis of this structure a series of perforations occur in the adult test along the long axis at regular intervals.

Another group of Eocene *Spiroloculinae* may be represented by *S. alata* Terquem (fig. 9). In this species the second chamber is shorter than in the preceding (*S. bicarinata*), being somewhat less than a half coil in length. The third chamber therefore begins earlier and it also is much shorter than in *S. bicarinata*, being but little more than a half coil in length. As a result, the fourth chamber which initiates the complete generic characters begins at a point a very little more than one coil beyond the apertural opening of the proloculum.

Other forms which have been usually grouped as *Spiroloculina* have a very different early development and will be considered after *Quinqueloculina* is taken up.

Derivations from Spiroloculina.—In the fossil forms especially there is a considerable development from *Spiroloculina* as a base. Uniserial developments take place in species usually assigned to *Articulina* but apparently do not belong to that genus. Another development is that seen in *Renulina* (figs. 10, 11) from the Eocene of the Paris Basin. Here is a genus apparently limited to the Eocene of the Paris Basin is a foraminifer, which in its general form is very like certain stages seen in the *Peneroplis* group, in *Orbiculina compressa* and *Orbitolites marginalis.* This form of test developed similarly in the various genera gives an excellent example of the parallelism that occurs in the foraminifera. In these cases the early development is different and the chambers differ internally even while exteriorly the same general form is developed.

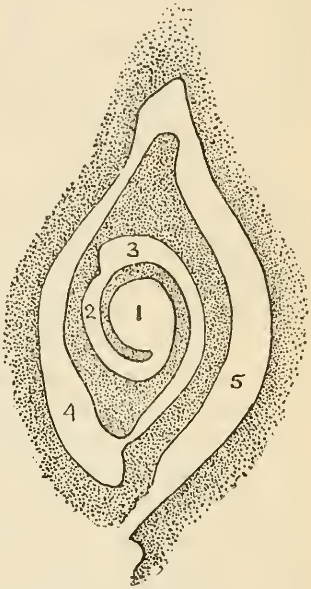


Fig. 9.—Spiroloculina alata Terquem. ×400. Eocene of Vandancourt, Paris Basin. Specimen showing the early chambers viewed by transmitted light. (1) Proloculum, (2) second cornuspiralike chamber, (3–5) chambers showing the typical half coil length.

The first four chambers of a specimen of *Renulina* are shown in figure 10. There is an oval proloculum (1) followed by a very short second chamber (2), shorter than that seen in any of the genera so far considered. This is but a quarter coil in length. Its wall is continuous with that of the proloculum and of the same thickness. It builds no floor on the surface of the proloculum. The third chamber (3) is long, making with the second chamber a complete coil. The fourth chamber (4) is short, one third of a coil in length, increasing considerably in height at the apertural end while there is a thickened flaring lip. Chambers 5 and 6 (fig. 11) are also a third of a coil in length, making one complete coil with chamber 4. The seventh chamber is similar. At this stage it is a closely coiled non-involute test, building the later chambers one-third of a coil in length.

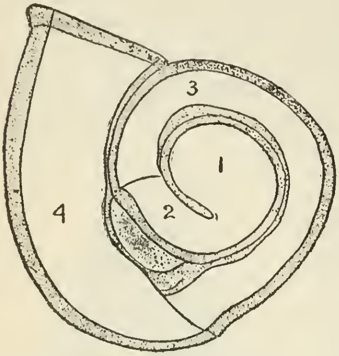


Fig. 10.—First four chambers of a specimen of Renulina from the Eocene of the Paris Basin. × 160.

Chamber 8 is very short in comparison with the preceding ones. Chamber 9 is also short but very much higher than earlier chambers, the outer wall taking a tangential direction. This tangential direction of the outer wall is continued in succeeding chambers, greatly increasing the height of the chambers which in all cases continue around to the preceding coil. This makes the form of test noted in forms of *Peneroplis*, *Orbiculina*, and *Orbitolites*, as already noted. This is brought about in the same mechanical way by the similar tangential position of the peripheral wall.

According to the published figures, in a later stage the chambers may extend back on both sides and form an extended chamber nearly meeting at opposite ends so that if continued slightly an annular growth would result. None of the series of specimens examined had reached this stage.

Development of Quinqueloculina.—*Quinqueloculina* and the various genera which are derived from it differ from all the other genera of the Miliolidae in having a plane of coiling which is constantly shifting with each newly added chamber, at least in the young. In all the genera so far considered the test has been planospiral.

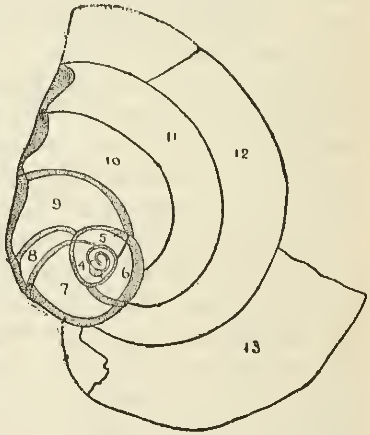


Fig. 11.—Complete specimen of Renulina, the early chambers of which are shown in fig. 10. × 13.

As the genera next to be considered coil in more than one plane, a longitudinal section can not usually be made so as to show the true relation of all the chambers. For the study of these genera, transverse sections passing through the proloculum are absolutely essential. The excellent detailed figures given by Schlumberger have been freely drawn upon for the study of these structures.

In *Quinqueloculina* there is an oval proloculum varying in size in the two forms of the species, microspheric and megalospheric, as already noted. It is followed by an elongate chamber about half a coil in length, closely coiled about one side of the proloculum, and builds no floor. The wall of this second *Cornuspira*-like chamber is of the same thickness and continues with the proloculum.

A longitudinal section of the first two chambers of *Quinqueloculina suborbicularis* is shown in figure 12. This is of the same abbreviated *Cornuspira*-like type as the second chamber in various other genera already described.

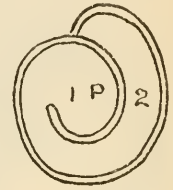


Fig. 12.—Quinqueloculina suborbicularis d'Orbigny. Section of young. × 300 (adapted from Schlumberger). P. proloculum.

The early development in *Quinqueloculina rugosa* d'Orbigny is shown in figure 13. The proloculum is circular in cross section and the second *Cornuspira*-like chamber being cut twice is shown on opposite sides of the proloculum at 2 and 2*a*. The third chamber, shown in cross section at 3, builds no floor, a character usually noted in this genus. Its outline in cross section is rounded and smooth. Its length, as is that of the succeeding chambers, is a half coil. Chamber 4 is added in another plane 144° of an arc from the position of its predecessor, chamber 3. Chamber 5 is added in a plane 144° from chamber 4, and so on for the sixth and seventh chambers. With the seventh chamber the generic character is attained, that of a test with five chambers visible from the exterior. Additional chambers are seen in figure 15. Chamber 8 is added in the same plane as chamber 3 and covers it; chamber 9 in the same plane as chamber 4, and so on. Succeeding chambers are added in planes 144° from one another, but the five planes in any one cycle are developed 72° of an arc from one another. This is similar in a general way to a 2/5 arrangement in the phyllotaxy of plants where succeeding leaves are developed 144° from one another, but the whole cycle of five leaves is made up of a series of radial planes 72° apart. In the vertical axis two and a half revolutions are made by five chambers, as each is a half coil in length, while in the horizontal axis two cycles are made before a chamber is added directly in the same plane as the last of the preceding series. In typical *Quinqueloculina*, then, after the seventh chamber each chamber is added directly outside its fifth preceding chamber. In *Quinqueloculina* the generic character is completed with this development, and in further growth simply an increase in size results from the addition of new chambers in this same series of planes. This character will be called "quinqueloculine" when seen in the young of other genera.

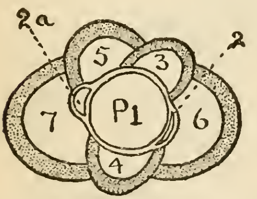


Fig. 13.—Early chambers of Quinqueloculina rugosa d'Orbigny. × 300 (adapted from Schlumberger).

In various species of *Quinqueloculina* there is a progressive development in the ornamentation, the earlier formed chambers being smooth and semi-elliptical in cross section as in the primitive chambers seen in the microspheric form throughout the genus. As shown in figure 14, there is a progressive development of ornamentation; in this case an increase in the number of costae from one in chamber 3 to a considerable number in chamber 13. In some individuals a definite senescent character is shown in the loss of these costae, and the resulting development of smooth chambers like that seen in its own young, the intermediate chambers as seen in section bearing distinct costae.

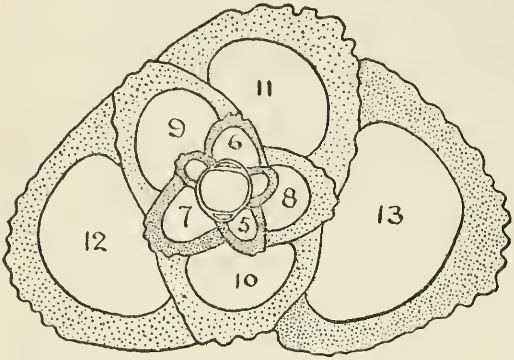


Fig. 14.—Quinqueloculina undulata d'Orbigny. × 150 (adapted from Schlumberger). Showing progressive increase in ornamentation, the numbers of costae increasing in number with new chambers.

There are both microspheric and megalospheric individuals developed in *Quinqueloculina*, but they differ only in the size of the proloculum and the total number of chambers in the adult, not in the general plan of their development. The fact that the complete stages in development shown by the microspheric form are not different from those of the accelerated megalospheric form may be taken as a definite indication that *Quinqueloculina* is a primitive form at the base of its own series. Succeeding genera discussed show added stages and a dropping out of certain of these in the megalospheric form. *Quinqueloculina* is considered as the primitive form from which the other genera of the quinqueloculine group have been derived by the addition of differential characters. The proof of this is the fact that they have a quinqueloculine stage in the young of at least their microspheric form.

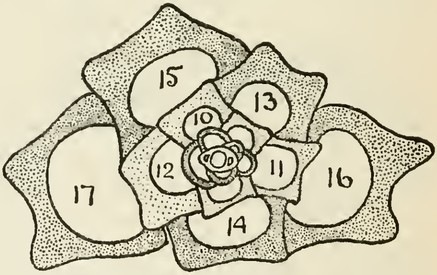


Fig. 15.—Quinqueloculina rugosa d'Orbigny. × 150 (adapted from Schlumberger). Showing progressive development of characters from the early smooth rounded chambers to the much angled and peripherally excavated chambers of the adult.

In figure 16 is given a diagrammatic figure showing the character of chamber development in a typical *Quinqueloculina*. The five planes are lettered A to E and the chambers numbered 1 to 9. The arrows indicate the direction of the addition of new chambers in the cycle. In the figure chamber 3 is in the plane A; chamber 4, 144° from it, is in the plane B; chamber 5 in plane C; 6 in plane D; 7 in plane E; and 8 again in plane A, overlying chamber 3.

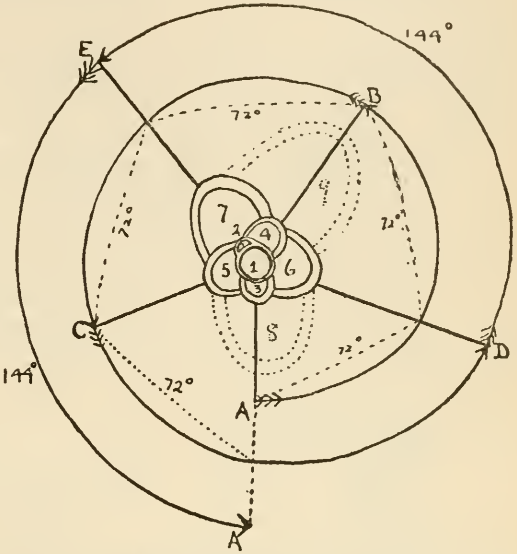
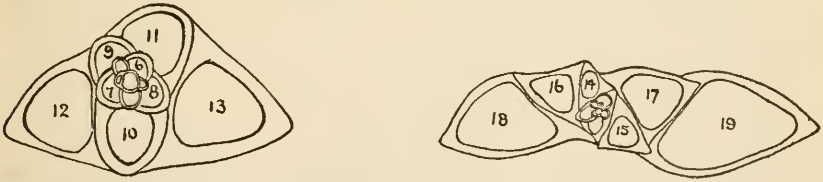


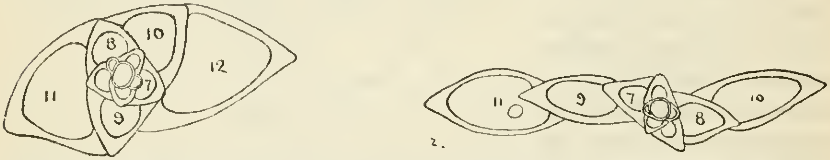
Fig. 16.—Diagrammatic section of Quinqueloculina. A–E, planes in which chambers are added. 1–9, chambers. Arrows indicate the direction of rotation in the addition of chambers.



Figs. 17, 18.—Massilina secans (d'Orbigny). 17, Early chambers of microspheric form. × 115. 18, complete specimen. × 13 (adapted from Schlumberger).

Derivatives from Quinqueloculina.—The later development from a quinqueloculine form may be seen in the regularly progressive series, *Triloculina*, *Biloculina*, etc., as will be considered later, but other genera may be considered as direct derivatives from a quinqueloculine stock. These, as in *Massilina* and *Hauerina*, may add chambers which are planospiral and comparable to *Spiroloculina*, except in the young or as in *Articulina*, where there is developed a uniserial later development with a quinqueloculine young. The development of *Massilina* in the two forms, microspheric and megalospheric, will give a good illustration of a typical derivative from *Quinqueloculina*. *Massilina secans* d'Orbigny gives in simple stages the development of characters which make up the genus *Massilina* Schlumberger. From a study of the development of this species it will be seen that this genus is one derived from *Quinqueloculina* by the addition of definite differential characters. Both the forms, those with a microspheric and megalospheric proloculum, have been found by Schlumberger. The early chambers of a specimen with a microspheric proloculum are shown in figure 17. There is a small proloculum followed by the usual *Cornuspira*-like chamber making a little more than a half coil in length. This chamber is shown cut once on the left side of the proloculum. The succeeding chambers, 3 to 13, are arranged on a quinqueloculine plan of growth, the chambers as added being in planes 144° from one another, five chambers thus appearing on the periphery in planes 72° from one another. In the adult, figure 18 of the same microspheric form, the quinqueloculine growth is seen to continue to the seventeenth chamber. The eighteenth and nineteenth chambers, instead of continuing the quinqueloculine plan of growth, are placed in planes nearly 180° from one another and initiate the adult character, that of chambers in an open coil lying in one plane.

A young individual of the megalospheric form is shown in figure 19. Without the last developed chamber, No 12, it would be taken for a young *Quinqueloculina.* There is a large proloculum followed by a second chamber of the usual *Cornuspira*-like form. Chambers 3 to 11 are arranged on the typical quinqueloculine plan as in the microspheric form already noted. Chamber 12, however, is added in a plane nearly 180° and from chamber 11 initiates the adult character. This specimen is then more accelerated than the microspheric specimen, figure 18, as it takes on this character several chambers earlier than did the microspheric. An adult specimen of the megalospheric form showing greater acceleration is shown in figure 20. Here the proloculum is nearly twice as large in the previous megalospheric specimen. Chambers 3 to 7 are arranged on the quinqueloculine plan, but chamber 8 is added in a plane 180° from chamber 7, thus initiating the adult character very early. This character did not appear in the other megalospheric specimen until the twelfth chamber and in the microspheric until the eighteenth chamber; chambers 8 to 11 are in an open coil in one plane, completing the development, while in both of the other specimens it was still in the quinqueloculine stage in the eleventh chamber.



Figs. 19, 20.—Massilina secans (d'Orbigny). Megalospheric form (adapted from Schlumberger). 19, Young specimen still in quinqueloculine stage. × 20. 20, Adult specimen. × 13.

As noted in other species, the microspheric form attains the largest size, as seen by comparing the two figures, figure 18 and figure 20, which are drawn with the same magnification. In the microspheric form, figure 18, there have been but two *Massilina* chambers built, while in figure 20, the megalospheric, four such chambers exist, yet the two specimens are of about the same diameter.

There is a tendency, especially in the microspheric form, to build a floor in the later chambers. In this specimen this character is taken on in the twelfth chamber and continued throughout the further growth.

Development of Triloculina.—A section of the test of *Triloculina schreiberiana* d'Orbigny with a microspheric proloculum is shown in figure 21. There is the usual form of proloculum followed by a *Cornuspira*-like second chamber. Chambers 3 to 10 are arranged on a quinqueloculine plan and the test is like *Quinqueloculina* at this stage. The chambers lie in planes 72° apart, but successively added chambers 144° from one another as in *Quinqueloculina*. Later chambers, 11 to 16, are arranged on a different plan, each chamber being added in a plane 120° from its preceding one, giving a test with but three chambers visible on the surface. The method of building here is a series of chambers made up of single cycles, in each of which each chamber lies on the outer side of its third preceding chamber instead of the fifth, as in *Quinqueloculina*. This method of growth may be called triloculine from the generic name *Triloculina*, this character being typical of the adult of that genus. The stages made out in the microspheric form of *Triloculina* are four—(1) proloculum, (2) *Cornuspira*-like chamber, (3) quinqueloculine chambers, (4) triloculine chambers.

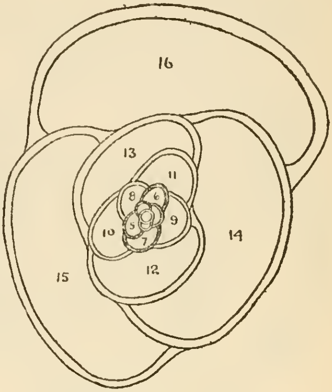


Fig. 21.—Chambers of microspheric specimen of Triloculina schreiberiana d'Orbigny (adapted from Schlumberger). × 33. Quinqueloculine chambers are shaded in the figure.

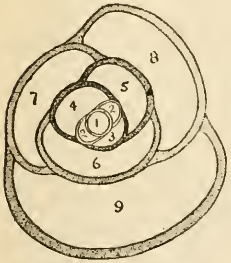


Fig. 22.—Early chambers of megalospheric specimen of Triloculina schreiberiana d'Orbigny (adapted from Schlumberger). × 66.

A section of megalospheric specimen of this same species is shown in figure 22. Here there is a large proloculum followed by a second chamber cut in two at opposite points in the section. The following three chambers, 3 to 5, are somewhat irregularly placed, but the number of degrees covered is about 275°, which gives an average of about 138° for each angle. This is closed to the 144° of a typical *Quinqueloculina*, and these three chambers represent the quinqueloculine stage in the development. These chambers, 3 to 5, form a reduced quinqueloculine stage, which does not even form a complete series. This is much more accelerated than the microspheric specimen, where there were eight chambers built on the quinqueloculine plan. Chambers 6 to 9 are arranged in a triloculine plan, being added in planes 120° from one another. The megalospheric form is thus more accelerated, taking on the triloculine character in the sixth chamber, a character not initiated in the microspheric specimen until the eleventh chamber.

It will then be seen that the megalospheric form completed its growth with the ninth chamber, but the microspheric specimen in its ninth had not even attained the adult triloculine character. In matter of size the megalospheric specimen, with its eighth chamber, had built a test of about the same size as the microspheric specimen with 16 chambers.

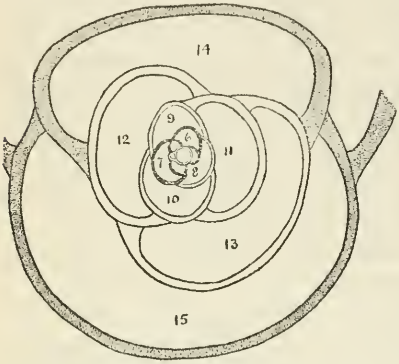


Fig. 23.—Biloculina ringens. Early chambers of microspheric form (adapted from Schlumberger). × 50. The early quinqueloculine chambers are shown with dark shading. The later triloculine stage unshaded and the final biloculine chambers in a light shading.

Development of Biloculina.—A section of *Biloculina ringens* in the horizontal plane is shown in figure 23. This specimen has a microspheric proloculum followed by a *Cornuspira*-like second chamber of the usual sort in this group, a half coil in length thus being cut at but one point in the section. Chamber 3 starts a quinqueloculine stage continued through chamber 8 of the usual arrangement seen in *Quinqueloculina*, chambers 72° apart but successively added in radial planes 144° apart, as shown in the adult of *Quinqueloculina* and in the young of *Triloculina*. Chamber 9 initiates the triloculine stage, and with chambers 10 and 11 completes a cycle of chambers 120° apart. This triloculine stage is here continued through chamber 14. Chamber 15 initiates the biloculine stage where chambers are added in planes 180° from one another, the newly added chamber covering all except the last previously formed chamber. Thus in typical *Biloculina* but two chambers are visible from the exterior. Further growth is an increase in size by the addition of new chambers on this biloculine plan, the number of these chambers depending largely upon the age of the individual.

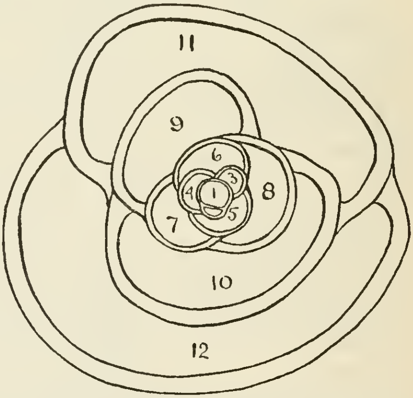


Fig. 24.—Megalospheric specimen of Biloculina ringens. × 80 (adapted from Schlumberger).

In its microspheric form, then, *Biloculina* develops a proloculum and *Cornuspira*-like second chamber, followed successively by chambers arranged on quinqueloculine and triloculine planes followed in the adult by chambers arranged on biloculine planes. A microsperic specimen of this species of *Biloculina* repeats in its own ontogeny characters seen in the adults of the more primitive types, *Cornuspira*, *Quinqueloculina*, and *Triloculina* in the order in which they were developed, as has already been noted in the ontogeny of those genera.

In specimens of various species of *Biloculina* where there is a megalospheric proloculum there is an accompanying acceleration of development as shown in figure 24, which is a section of *B. ringens* of the megalospheric form. A proloculum and *Cornuspira*-like second chamber form the first and second stages. Next, instead of a quinqueloculine stage, a triloculine stage is at once taken on by chamber 3 and continued through chamber 10. The angle between the chambers is rather constant, averaging 120°, except that between chambers 9 and 10 where the change from the 120° of triloculine to the 180° of biloculine growth occurs. There the angle is a medium between these two, as is also that between chambers 10 and 11. The biloculine stage starts definitely with chamber 11. This megalospheric specimen is then more accelerated than the microspheric, skipping the early quinqueloculine stage and taking on the adult biloculine plan of growth in chamber 11, not reached in the microspheric specimen until the fifteenth chamber.

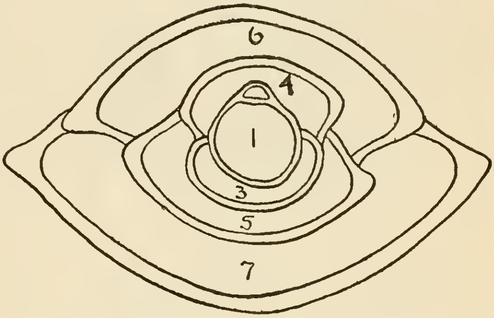


Fig. 25.—Megalospheric specimen of Biloculina murrhyna, with the biloculine stage begun at once, the quinqueloculine and triloculine stages being skipped. × 200 (after Schlumberger).

A section of a specimen of *Biloculina murrhyna* with an exceptionally large megalospheric proloculum is shown in figure 25. The proloculum is very large and the *Cornuspira*-like second chamber small in comparison. Chambers 3 and 4, instead of forming the beginning of a quinqueloculine stage or even the triloculine stage as in the preceding here begin directly upon the biloculine character, the quinqueloculine and triloculine stages having been entirely skipped.

Development of Idalina.—The genus *Nevillina* as shown in the figures on plate 35, after Sidebottom, shows that we have here a genus in the present seas going a stage beyond *Biloculina* and developing almost a single chamber externally in the adult. In the fossils, however, even better examples occur. In *Idalina*, a genus from the Upper Cretaceous of Southern Europe, the highest type of development in the quinqueloculine group is shown. *Idalina antiqua* Munier-Chalmas and Schlumberger occurs in the two forms, one with a microspheric, the other with a megalospheric proloculum. The figures used are taken from those of the two authors mentioned. The development of a specimen with a microspheric proloculum is shown in figure 26. There is a globular proloculum followed by a short *Cornuspira*-like chamber as the second stage in development. Following the second, chambers 3 to 23, inclusive, are arranged on a quinqueloculine plan of chambers in radial planes 144° from one another. This relation of the chambers is not always apparent from the position of the successive chambers, as there may be a considerable departure from the typical angle in individual chambers, but the average of the angles of the planes during this quinqueloculine stage is always close to 144°.

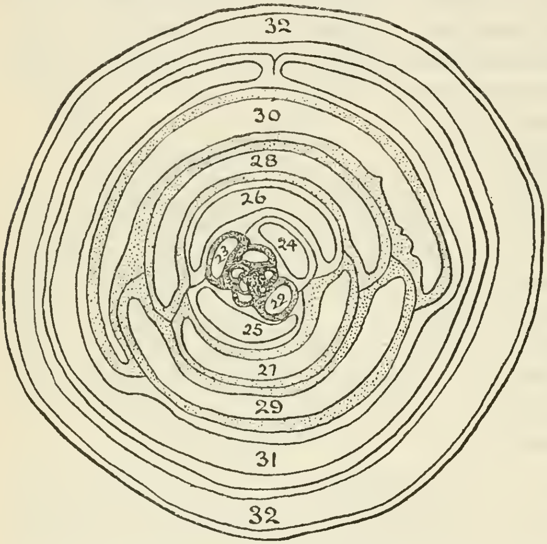


Fig. 26.—Section of a microspheric specimen of Idalina antiqua. × 25 (after Munier-Chalmas and Schlumberger). Early quinqueloculine stage, chambers 3–23 shown in dark shading, triloculine stage, 24–26, unshaded; biloculine stage, 27–30, in light shading; uniloculine stage, 31, 32, unshaded.

Two sections figured by Schlumberger were measured as to the angles between successive chambers during the quinqueloculine stage. In one case the average of 11 angles was 137°; in the other the average of eight angles was 142°. While these early chambers were not as uniformly arranged as in adult *Quinqueloculina*, the average is very close. Following the quinqueloculine stage chambers are developed, arranged on a triloculine plan, the chambers added in radial planes 120° from one another. In the larger figure chamber 24 is 115° from the plane of chamber 23; chamber 25 is 130° from the plane of chamber 24—an average of 122.5° for these two chambers. In another section of *Idalina* two chambers in a similar situation gave 124° and 123°, respectively.

Following the triloculine stage the angle of the planes of addition increase until 180° is attained. There is usually one chamber which bridges over this gap between 120° and 180°, or between the triloculine and biloculine stages, the chamber not fully referable to either plan. In figure 26, for example, the angle between chambers

25 and 26 is about 156°, that between succeeding chambers being about 180°, so that chamber 25 is more than triloculine and less than biloculine. In another of Schlumberger's figures the relation of the change between triloculine and biloculine stages is still more graphically shown, the angles of chambers after the quinqueloculine stage measuring 124°, 123°, 150°, and 180°, respectively. The first two are distinctly triloculine and the last one is distinctly biloculine, the next to the last bridging over the gap almost exactly, the 150° of the angle being exactly halfway between the ideal triloculine angle of addition of chambers, 120°, and that of biloculine addition, 180°. As a rule, the triloculine stage in *Idalina* seems to be short and fewer in number of its chambers than either the preceding quinqueloculine stage or the succeeding biloculine stage, only three chambers being usually arranged on the triloculine plan.

Following the triloculine stage there is developed a definite biloculine stage with chambers added in planes 180° from one another. In the specimen figured there are five such chambers, 26 to 30, inclusive. Following the biloculine stage chambers are added which completely encircle the previously formed chambers so that but one chamber is seen from the exterior. This completes the development and is a stage higher than seen in living members of the Miliolidae except possibly *Nevillina coronata* (Millett).

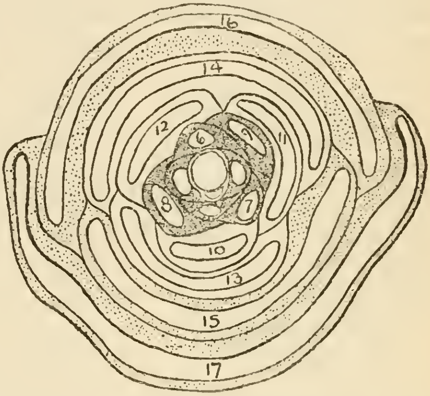


Fig. 27.—Section of a megalospheric specimen of Idalina antiqua. × 25 (after Munier-Chalmas and Schlumberger). Quinqueloculine stage in heavy shading, triloculine stage unshaded, biloculine stage in light shading.

A section of a specimen of *Idalina antiqua* with a megalospheric proloculum is shown in figure 27. The proloculum is much larger than in the microspheric form, but not as large as in certain other specimens next considered. Following the proloculum is the *Cornuspira*-like second chamber. The third stage is represented by chambers 3 to 10, inclusive, arranged on a quinqueloculine plan, in planes 144° apart as added. The fourth stage is formed by chambers 11 to 13, arranged on a triloculine plan, in planes 120° apart. Chamber 14 initiates the biloculine stage, not developed in the microspheric specimen until the twenty-seventh chamber. The uniloculine stage had not been attained in the specimen figured, the last-formed chamber, No. 17, being still biloculine.

Another specimen with a larger megalospheric proloculum (fig. 28) shows the following development. A large proloculum is followed by a *Cornuspira*-like second chamber. Chambers 3 and 4 are arranged on a quinqueloculine plan 144° apart, in the other megalospheric specimen represented by 8 chambers, and in the microspheric specimen by 22. The triloculine stage is initiated by chamber 5 and the biloculine by the eighth.

Some of the very large megalospheric proloculi are followed in the section directly by the biloculine stage, skipping entirely the quinqueloculine and triloculine stages.

Idalina and the other uniloculine genera with similar developmental stages represent the height of development that it seems can be reached along this line. Certain genera—*Lacazina*, for example—may be more complex by the addition of labyrinthic partitions in the interior of the chambers, similar to the labyrinthic interior of *Fabularia*, which is otherwise like *Biloculina*. These uniloculine genera, then, bring to a climax the progressive development of the quinqueloculine group, and therefore the highest type of development in the family of the Miliolidae, with the exception possibly of the *Peneroplis* group, which in many ways are different from all other members of the family.

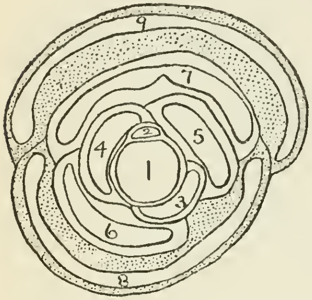


Fig. 28.—Section of a specimen of Idalina antiqua with a large megalospheric proloculum (after Munier-Chalmas and Schlumberger).

Development of Peneroplis group.—The development of typical specimens of *Orbitolites* and associated genera are considered under those genera in the sytematic portion of the present paper and need not be further considered here except that they have the proloculum and *Cornuspira*-like second stage as in all other members of the family.

General lines of development.—From the preceding detailed descriptions of the development seen in certain genera it will be seen that the first two stages in all the members of the family, at least in the microscopic form, consist of a proloculum and second chamber apparently built by one continuous process and similar to the actual "embryonic" young which have been actually seen in the parent tests in several genera. Except for the length of the second chamber this stage has the characters of an adult *Cornuspira*, therefore that genus should be considered the basal member of the Miliolidae.

Following *Cornuspira* there are a series of genera which, like *Opthalmidium*, gradually assume division of the tube into chambers of decreasing length, following a long *Cornuspira*-like stage, and the chambers all arranged in a planospiral manner. From here there are a number of genera which take on uniserial or broadly flaring later developmental stages, but still keep to a single plane.

The more specialized group represented by *Quinqueloculina* as a basal member after the second *Cornuspira*-like stage develops chambers in constantly changing but definitely related planes. The earliest of these as seen in the ontogeny of various forms is quinqueloculine, chambers added in planes successively 144° apart and taking two horizontal whorls to complete a cycle. Following this in the ontogeny is a triloculine stage in higher genera with planes 120° apart, followed in some genera by a biloculine stage with planes 180° apart, and this followed in the highest genera by a uniloculine stage where chambers almost entirely include the previously developed chambers. These stages are especially complete in the microspheric forms of the species. The series of stages quinqueloculine, triloculine, biloculine, uniloculine is never, so far as has been seen, in any way reversed, and is only changed by the dropping out of stages in the accelerated megalospheric form. All of the four stages above mentioned are represented by generic types, the species of which show both microspheric and megalospheric forms.

Much of the apparent "variation" in this group may be directly traced to the differences in the microspheric and megalospheric forms and the various stages in development represented by the material at the time of collecting, especially if living tests are collected. By a full series of specimens and careful sectioning it should be possible to much more clearly define specific limits of true variation and a realization of the stages of development in the two forms of the species, a refinement which has not hitherto been attempted in any large series.

SYSTEMATIC TREATMENT.

Family 10. MILIOLIDAE.

Test typically calcareous, imperforate except in the very early stages of certain genera, porcellanous; sometimes the exterior with arenaceous covering, but always on an imperforate calcareous base, aperture typically with a tooth variously modified in different genera.

This family is one with a similar young throughout the group in the very early stages of at least the microspheric form of each species. The greatest number of species and individuals occur in the shallow waters of tropical seas, where, as in the West Indies, certain species such as *Orbiculina adunca* make up a large percentage of the foraminiferal content of shallow-water dredgings. The various species of *Orbitolites* are among the largest of the living foraminifera and are a conspicuous factor of the shallow water dredgings of certain parts of the Indo-Pacific region especially. The members of the family, however, are by no means limited to shallow tropical seas, as certain genera, especially *Biloculina*, are conspicuous members of deep-water faunas, and in colder regions the prevalence of *Biloculina* in the "cold area" of the north Atlantic led Brady to designate the bottom as "*Biloculina* clay."

Subfamily 1. CORNUSPIRININAE.

Test usually free, the early stages composed of a proloculum and elongate, coiled second chamber, later chambers typically planospiral, of various lengths in typical chambers of the included genera.

Genus CORNUSPIRA Schultze, 1854.

Orbis Philippi (part), Enum. Moll. Siciliae, vol. 2, 1844, p. 147.

Operculina Czjzek (part), in Haidinger's Nat. Abhandl., vol. 2, 1848, p. 146.

Cornuspira Schultze (type, *C. foliacea* Philippi), Organismus Polythal., 1854, p. 40.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 198.

Spirillina Williamson (part), Rec. Foram. Great Britain, 1858, p. 91.

Description.—Test consisting of a proloculum followed by a long coiled tubular chamber, typically without septae, complanate, the open end serving as the aperture, occasionally somewhat constricted or with a thickened lip; wall porcellanous.

This genus is the simplest of those of the whole family of the Miliolidae and is typical of the early development throughout the family at least in the microspheric form in highly accelerated species. It is very similar to the primitive genera, *Ammodiscus* in the Lituolidae and *Spirillina* in the Rotalidae.

Some authors have treated the three genera, *Ammodiscus*, *Cornuspira*, and *Spirillina* as really the same thing with a selective character determining the kind of wall. It seems much better, however, to take them as instances of parallelism in various families, much as are found elsewhere in other groups.

As a primitive genus *Cornuspira* should theoretically be found early in the paleontological development of the family, and such is the case, specimens referable to the genus having been recorded from the Lias. However, as the type of wall may be obscured, the mesozoic specimens are more or less dubious in character between *Spirillina* and *Cornuspira*. Throughout the Tertiary it is found very positively.

CORNUSPIRA FOLIACEA, (Philippi).

Plate 1, fig. 1; plate 2, fig. 1.

Orbis foliaceus Philippi, Enum. Moll. Siciliae, vol. 2, 1844, p. 147, pl. 24, fig. 26.

Cornuspira planorbis Schultze, Organismus Polythal., 1854, p. 40, pl. 2, fig. 21.

Spirillina foliacea Williamson, Rec. Foram. Great Britain, 1858, p. 91, pl. 7, figs. 199-201.

Cornuspira foliacea Carpenter, Parker, and Jones, Introd. Foram., 1862, p. 68, pl. 5, fig. 16.—Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 121, pl. 1, figs. 8, 9.—Parker and Jones, Philos. Trans., vol. 155, 1865, p. 408, pl. 15, fig. 33.—Bütschli, in Bronn, Klassen und Ordnungen, Thier-Reichs, 1880, p. 189, pl. 4, fig. 8; pl. 8, fig. 1.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 120, pl. 9, figs. 308, 310.—H. B. Brady, Rep.

Voy. *Challenger*, Zoology, vol. 9, 1884, p. 199, pl. 11, figs. 5–9.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 326, pl. 12, figs. 1*a–b*.—EGGER, Abhandl. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 247, pl. 3, figs. 20, 21.—FORNASINI, Mem. Accad. Sc. Istit. Bologna, ser. 5, vol. 3, 1893, p. 431, pl. 1, fig. 4.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 106, pl. 18, fig. 834; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 79.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 114, pl. 1, fig. 16.—MILLETT, Journ. Roy. Micr. Soc., 1898, p. 612.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 123.

Description.—Test flattened, early portion of the tubular chamber of nearly uniform dimensions, but in later development rapidly increasing in height and forming a broad flat test; wall smooth except for occasional thickenings over the lines of growth; aperture a long slit the entire height of the tubular chamber.

Diameter of North Pacific specimens hardly more than 2 or 3 mm.

Distribution.—Goës records *Cornuspira foliacea* from two *Albatross* stations in the eastern tropical Pacific, one D3375 in 1,201 fathoms and the other only the depth is given, 700 fathoms.

There is apparently no mounted Pacific material in Goës's collection.

Bagg records it from off the Hawaiian Islands, not common at *Albatross* station D4017 in 309 fathoms. His single mounted specimen from this station which I have examined seems to be immature, but is undoubtedly this species. The only material I have had belonging definitely to this species is from *Albatross* station D4900 in 139 fathoms, off Japan, bottom temperature 52.9° F.

In the *Challenger* report Brady speaks of this species as more common in the Atlantic than elsewhere, and it certainly, from the material I have had, appears to be decidedly uncommon in the North Pacific.

Both microspheric and megalospheric forms occur.

CORNUSPIRA INVOLVENS (Reuss).

Plate 1, fig. 2; plate 2, fig. 2.

Operculina involvens REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 370, pl. 45, fig. 20.

Cornuspira involvens REUSS, Sitz. Akad. Wiss. Wien, vol. 48, 1863 (1864), p. 39, pl. 1, fig. 2.—JONES, PARKER, and H. B. BRADY, Pal. Soc., vol. 19, 1866, p. 3, pl. 3, figs. 52–54.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 200, pl. 11, figs. 1–3.—BALKWILL and MILLETT, Journ. Micr., vol. 3, 1884, p. 23, pl. 1, fig. 1.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 327, pl. 12, fig. 2.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888; p. 216, pl. 40, figs. 1–3.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 484, pl. 11, figs. 4, 5.—EGGER, Abhandl. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 246, pl. 3, figs. 18, 19.—T. RUPERT JONES, Pal. Soc., 1895, p. 128, pl. 3, figs. 52–54.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 114.—MILLETT, Journ. Roy. Micr. Soc., 1898, p. 612.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1907, p. 22, pl. 2, fig. 46.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908; p. 123.

Description.—Test biconvex, the edges becoming somewhat thicker as growth progresses, tubular portion of nearly equal height throughout, slightly embracing; wall smooth except for occasional slight varices of growth; aperture nearly the size of the open end of the tube.

Diameter 1 mm. or slightly more.

Distribution.—Brady notes the occurrence of this species in the North Pacific, but gives no definite stations. Bagg records it from two stations off the Hawaiian Islands, *Albatross* D4017 and D4174 in 305 and 735–865 fathoms, respectively. His material which I have examined is typical.

In the material I have had there are specimens from *Albatross* station 3608 in 276 fathoms off the Galapagos, *Nero* 2071 in 271 fathoms off the Hawaiian Islands, D4900 in 139 fathoms, and D4875 in 59 fathoms off Japan. The specimens from D4900 were larger and finer than those from the other stations.

In the *Tuscarora* material this species has occurred at the following stations: 5, in 1,200 fathoms, latitude 37° 04′ N.; longitude 123° 22′ W.; 11, in 437 fathoms, latitude 33° 46′ N.; longitude 140° 21′ E.; and 42, in 108 fathoms, latitude 27° 16′ N.; longitude 141° 56′ E.

Both microspheric and megalospheric forms of the species occur, the microspheric specimens being considerably larger than the megalospheric.

CORNUSPIRA LACUNOSA H. B. Brady.

Plate 2, fig. 3.

Cornuspira lacunosa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 202, pl. 113, fig. 21.

Description.—"Test discoidal, biconcave, peripheral edge rounded; convolutions numerous, narrow near the center; aperture dome-shaped; surface decorated, especially on the outer whorls, with a series of irregular, anastomosing costae, the main lines of which are more or less parallel to the axis of growth. Diameter one fiftieth inch (0.5 mm.) or rather more."

Distribution.—Brady described this species from *Challenger* station 185, off Raine Island, Torres Strait, in 155 fathoms. It seems to be a rare species to judge from the absence of data. From *Albatross* station D4900 in 139 fathoms off Japan where many species allied or identical with those of the Torres Strait region occur there were obtained several specimens referable to this species. They are very different, however, in certain characters. The early portion is undoubtedly identical with the species figured by Brady but in the larger specimens which show the later development there is a modification of the ornamentation. In the last-formed coil there is a loss of the lacunose ornamentation and the wall is nearly smooth except for very definite but fine longitudinal striae. The last-formed whorl is usually distinctly broader than that portion showing the lacunose ornamentation. As Brady had the species from but the one station and the number of specimens is not hinted at it seems reasonable to suppose without further data that the *Challenger* specimens were immature and did not show the full specific characters which the *Albatross* specimens show.

The *Albatross* specimens are also much larger than the measurements given by Brady but the lacunose portion usually does not exceed 1 mm., another fact which seems to substantiate the idea that the *Challenger* material was immature.

In specimens which have a broadened last coil there is a tendency to lose the ornamentation progressively as in certain species of *Cristellaria.* The prominent striae are retained on the inner border of the chamber, while the peripheral portion is nearly if not quite smooth.

Altogether these form a decidedly interesting suite of specimens.

In connection with the present material it is worthy of note that Chapman has figured a specimen from the Tertiary of Victoria as *Cornuspira striolata* Brady,[1] which has very close affinities with the Japanese material. One or two of our specimens have just such a terminal portion as that figured by Chapman and the early chambers while indistinct in that figure seem to be rather coarsely striate or even lacunose. As the original specimens of *C. striolata* from the Faroe Channel had a very highly developed peripherally expanded test and those of Goës also from the subarctic waters had a similar form it seems as if we had here in the Indo-Pacific region a definite species, the range of which may probably be found to be from Australia northward to Japan and existing as a fossil in the Tertiary at least of Australia.

The large recent specimens which show the expanded last coil are microspheric, and it may be that the megalospheric form does not have the later stages. Brady's figure of *C. lacunosa* seems, compared with our specimens, to be megalospheric and stops at this point in its development.

Genus OPTHALMIDIUM Zwingli and Kübler, 1870.

Oculina Kübler and Zwingli (type, *O. porosum* Zwingli and Kübler), Neujahrsblatt Burgersbibl., Winterthur, 1866, p. 11.

Opthalmidium Zwingli and Kübler, Foram. Schweiz Jura, 1870, p. 46.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 188.

Hauerina H. B. Brady (part), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 54.

Description.—Test in general planospiral, compressed, all chambers visible from the exterior on both sides, proloculum globular, followed by a coiled second chamber making usually two or more coils, the following chambers gradually decreasing in relative length, more or less loose coiled, the intermediate area filled in with a shelly plate; aperture at the end of the chamber, rounded, without lip or teeth.

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[1] Journ. Linn. Soc. Zoology, vol. 30, 1907, p. 23, pl. 3, fig. 47.

The genus *Opthalmidium* is very evidently an advance from *Cornuspira* toward a condition seen in the genus *Spiroloculina*. The relative length of the second chamber shows a decidedly primitive character and the succeeding relative shortening of the chambers is also decidedly primitive, characters which in the development of *Spiroloculina* are greatly reduced by acceleration of development.

Opthalmidium is rather rare in recent oceans, but in the Lias especially seems to have been much more abundant and characterized by more species than at present.

OPTHALMIDIUM INCONSTANS H. B. Brady.

Plate 3, figs. 1–4.

Hauerina inconstans H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 54.

Opthalmidium inconstans H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 189, pl. 12, figs. 5, 7, 8.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 216, pl. 40, figs. 12, 13.—EGGER, Abhandl. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 244, pl. 3, figs. 6, 49.—MILLETT, Journ. Roy. Micr. Soc., 1898, p. 608.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 398.

Description.—Test planospiral, much compressed, chambers consisting of a globular proloculum, followed by a *Cornuspira*-like coiled second chamber, making two or more volutions, this in turn followed by chambers progressively relatively shorter in length until the adult condition is reached, where chambers are half a volution in length or less, chambers nearly circular in transverse section with a thin wide flange on the peripheral border, chambers often slightly less coiled toward the apertural end, leaving a space filled by a thin plate of shelly material; aperture circular without lip or teeth.

Diameter, about 1.5 mm. in the largest specimens.

Distribution.—Brady records in his generalized statement that he had this species from the North Pacific, but gives no definite stations.

The only material I have had is from *Nero* station, 1466, in 234 fathoms off Guam.

OPTHALMIDIUM TUMIDULUM H. B. Brady.

Plate 3, fig. 5.

Opthalmidium tumidulum H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 189, pl. 12, fig. 6.

Description.—"Test complanate, commencing growth as a rounded tube coiled upon a somewhat inflated primordial chamber in a planospiral manner; the earlier convolutions nonseptate and cornuspira-like, the subsequent ones constricted at intervals and eventually more or less regularly *Spiroloculine;* peripheral edge rounded. Aperture arched or rounded, formed of the slightly constricted end of the tube.

"Longer diameter, one-thirtieth inch (0.8 mm.)."

Distribution.—Brady gives a single North Pacific record for this species, *Challenger* station 241 in 2,300 fathoms. I have found no specimens in the material I have examined. The figures and description are from Brady.

Genus SPIROLOCULINA d'Orbigny, 1826.

Spiroloculina d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 298 (Type *S. depressa,* d'Orbigny).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 147.

Description.—Test composed of chambers arranged planospirally, all visible typically from opposite sides of the test, early chambers after the proloculum sometimes a coil or more in length, but the adult chambers one-half coil in length; aperture typically somewhat produced; aperture circular, with a prominent lip and a bifid tooth occasionally, with a secondary tooth directly opposite the primary one.

Certain of the species which were described as *Spiroloculina* have typical quinqueloculine development until the final chambers, and for these the genus *Massilina* was created by Schlumberger.

SPIROLOCULINA DEPRESSA d'Orbigny.

Plate 3, figs. 6–10.

Spiroloculina depressa d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 298.—Williamson, Rec. Foram. Great Britain, 1858, p. 82, pl. 7, fig. 177.—Terquem, Mem. Soc. Geol. France, ser. 3, vol. 1, 1878, p. 54, pl. 5, fig. 11.—Wiesner, Archiv. Prot., vol. 25, 1912, p. 210.

Spiroloculina limbata H. B. Brady (not d'Orbigny), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 150, pl. 9, figs. 15–17.

Description.—Test in side view elliptical or rounded, in end view with the sides nearly parallel, the periphery flattened or even slightly convex, chambers numerous, in front view with the periphery and the inner margin of the chamber raised, the intermediate space more or less depressed, giving the appearance of having limbate sutures; apertural end of the chamber usually with a short neck hardly extending beyond the margin of the test, lip little if at all developed; aperture nearly circular; tooth single with a bifid tip; wall smooth, dull.

Length, 1–1.5 mm.

Distribution.—Brady in the *Challenger* report includes the North Pacific indirectly in his statement of distribution for this species, but gives no definite localities.

In the material that I have examined the species has occurred a number of times, as follows: *Tuscarora* 2, in 108 fathoms, latitude 27° 16′ N.; longitude 141° 56′ E.; *Nero* 2033 in 249 fathoms, 2034 in 175 fathoms, 2036 in 82 fathoms, and 2041 in 33 fathoms, all off the Hawaiian Islands; *Albatross* H4881 in 316 fathoms in Colnett Strait, D4807 in 44 fathoms off Hakodate, Japan, D4874 in 66 fathoms eastern channel, Korea Strait, D4900 in 139 fathoms Eastern Sea of Japan, and D5068 in 77 fathoms Suruga Gulf, Japan; Gaspar Straits, North Pacific Exploring Expedition, Captain Rodgers. An extreme form from *Nero* 1466, in 234 fathoms off Guam, is shown in figure 7.

SPIROLOCULINA CANALICULATA d'Orbigny.

Plate 4, figs. 1–3.

Spiroloculina canaliculata d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 269, pl. 16, figs. 10–12.

Spiroloculina impressa H. B. Brady (not Terquem), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 151, pl. 10, figs. 3, 4.

Description.—Test elliptical in front view, the ends of the final chamber projecting somewhat at both ends, in end view, the sides nearly parallel, the angles of the periphery of the chamber produced into thin plates, the space between being typically concave, chambers rather neatly joined to one another, the joining being flush so that little difference in the surface is noted from the exterior to the center; apertural end produced into a cylindrical neck, with a flaring, phialine lip, the aperture itself being circular with a bifid tooth on the inner margin, the projections forming a concave plate, often an accessory simple tooth on the opposite border of the aperture, wall smooth and shining, white.

Length, 1–1.5 mm.

Distribution.—The only North Pacific record for this species that is published is that given by Brady, a *Challenger* station in the Philippine region, in 95 fathoms.

In the *Tuscarora* material the species has occurred at three stations near the Bonin Islands, 1, in 73 fathoms, latitude 27° 07′ N.; longitude 142° 07′ E.; 2, in 108 fathoms, latitude 27° 16′ N.; longitude 141° 56′ E.; and 3, in 345 fathoms, latitude 27° 47′ N.; longitude 141° 50′ E. There are four stations for the species in the *Albatross* material off Japan, D4874 in 66 fathoms and D4875 in 59 fathoms, both in the eastern channel of Korea Strait; D4900 in 139 fathoms, Eastern Sea of Japan, and D4949, 110 fathoms.

From the *Nero* material in the vicinity of the Hawaiian Islands it has occurred at stations 2040 in 21 fathoms and 2071 in 271 fathoms.

This species may be most easily distinguished by the deeply concave periphery of the chambers between the two prominent platelike margins of the chamber. The true *S. impressa* of Terquem has a flat periphery instead of a concave one.

SPIROLOCULINA GRATELOUPI d'Orbigny.

Plate 4, figs. 4, 5.

Spiroloculina grateloupi D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 298.—TERQUEM, Mém. Soc. Geol. France, ser. 3, vol. 1, 1878, p. 52, pl. 5, figs. 5, 6.—WEISNER, Archiv. Prot., vol. 25, 1912, p. 208.

Spiroloculina excavata H. B. BRADY (not d'Orbigny), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 151, pl. 9, figs. 5, 6.

Description.—Test elongate, broadest in the center, tapering toward either end, chambers rapidly thickening as added, in end view the periphery much the broadest portion of the test, central portion deeply excavated; periphery of the chambers in end view much convex, especially in the central portion, the edges broadly rounded; chambers evenly curved, the final chamber somewhat projecting both at the base and at the apertural ends, the latter having a decided neck with a phialine lip, the aperture itself rounded and with either a single tooth with a bifid end, the two projections forming a concave extremity or in some cases a pair of such bifid teeth opposite one another; surface of the test dull, somewhat roughened.

Length, 1–1.5 mm.

Distribution.—From the existing records this seems to be a species of a rather tropical distribution. The only published record for the North Pacific is that given by Brady, *Challenger* station 260A, in 40 fathoms, on the Honolulu coral reefs.

I have had material from the same region and from *Nero* station 2042 in 55 fathoms, Waimea Bay, Hawaiian Islands It has also occurred in material from Hongkong and from Singapore. In the material of the North Pacific Exploring Expedition, Captain Rodgers, it occurs in Gaspar Straits. From the *Albatross* material it occurs from H4882, in 248 fathoms, in Colnett Strait.

SPIROLOCULINA ACUTIMARGO H. B. Brady.

Plate 5, fig. 1.

Spiroloculina acutimargo H. B. BRADY, Rep. Voy. *Challenger*, vol. 9, 1884, p. 154, pl. 10, figs. 12–15.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 119.

Description.—"Test oval, complanate, thin, slightly convex on both sides; peripheral margin acute or carinate, extremities obtuse or slightly rounded; chambers arcuate, angular, or carinate at the outer margin, either slightly embracing or separated by the intervening wing of the previous convolutions; aperture small, sometimes in a produced tubular extension of the final segment.

"Length, one-thirtieth inch (0.85 mm.)."

Distribution.—The only recorded stations for this species in the North Pacific are those given by Bagg off the Hawaiian Islands, *Albatross* D4174, 735–865 fathoms, D4025, 275–368 fathoms, and H4694, in 865 fathoms.

In the material which I have had the species has been observed but once, *Nero* station 990, in 859 fathoms off Guam. This specimen is here figured. It is rather more extreme in its flattened character than in the figures given by Brady, reminding one somewhat of *Opthalmidium inconstans.* The specimen agrees with both the figure and description given by Brady in that the platelike carina separates the chambers from one another very distinctly. In this character the present species differs from that described here as *S. tenuimargo* which, although having a carina well developed on the last-formed chambers, does not have the chambers well separated in the body of the test.

SPIROLOCULINA TENUIMARGO, new species.

Plate 5, figs. 2, 3.

Description.—Test much compressed, planospiral, chambers numerous, usually more swollen toward the basal end, inflated, nearly circular in transverse section, the apertural end somewhat produced, surface smooth; periphery of the test with a distinct, rather broad, sharp, platelike carina, in young specimens rather even, but in older ones more or less irregular; chambers closely adjacent to one another, not separated; apertural end with a slightly produced and slightly flaring lip; aperture round.

Length, slightly less than 1 mm.

Distribution.—Specimens were obtained from two stations; the type, Cat. No. 9153, U. S. N. M., from *Nero* 1466, in 234 fathoms off Guam and another lot from *Albatross* D4967, in 244 fathoms off the coast of Japan.

This species while having a marginal carina as in *S. acutimargo* H. B. Brady, has the chambers closely adjacent to one another and not separated by a flat platelike portion as in that species, the form of the chambers is also very different from those of our species, being differently curved and having the basal portion much swollen, especially in the earlier chambers.

SPIROLOCULINA TENUISSIMA Reuss.

Spiroloculina tenuissima Reuss, Sitz. Akad. Wiss. Wien, vol. 55, 1867, p. 71, pl. 1, fig. 11.

Spiroloculina tenuis H. B. Brady (not Czjzek) (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 152, pl. 10, figs. 9, 10 (not 7, 8, 11).

Description.—Test very thin, translucent, elongate, compressed, in front view tapering toward either end, chambers long and narrow, peripheral margin broadly rounded, chambers in transverse section, circular; apertural end produced into an elongate neck, aperture rounded usually without distinct teeth, wall smooth.

Length, usually less than 0.5 mm.

Distribution.—Bagg records this species as *S. tenuis* from six *Albatross* stations in the vicinity of the Hawaiian Islands, varying in depth from 104 to 1,259 fathoms.

The species occurred at the following stations in the *Nero* and *Albatross* material: *Nero* 1464 in 891 fathoms off Guam; 1054 in 1,863 fathoms, 1065 in 1,321 fathoms, 1075 in 1,029 fathoms, and 1122 in 1,926 fathoms, all between Guam and Japan: *Albatross* D4979 in 943 fathoms off the coast of Japan.

The species described by Czjzek has a Miliolino early development and is not a true *Spiroloculina.* Most of the stations for this species are in comparatively deep water.

SPIROLOCULINA ROBUSTA H. B. Brady.

Spiroloculina robusta H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 150, pl. 9, figs. 7, 8.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 296, pl. 42, figs. 1, 2.

Description.—"Test oblong or oval, with angular or pointed extremities, compressed or complanate; broad and thick, slightly concave on both faces, rounded at the periphery. Segments few in number, much arched; the inner margin of each overlapping a considerable portion of the previous segment on the same side, their lateral surfaces crested by angular ridges.

"Length, one-tenth inch (2.5 mm.)."

This species was described by Brady from the region of the West Indies, but there are two lots of material in that from the North Pacific which seem to belong to it. These are both from the same general region, *Tuscarora* 58, in 814 fathoms, latitude 26° 52′ N., longitude 142° 21′ E.; and *Nero* 1308 in 1,040 fathoms.

SPIROLOCULINA MILLETTI Wiesner.

Plate 5, fig. 4.

Spiroloculina nitida H. B. Brady (not *S. nitida* d'Orbigny, 1826) Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 149, pl. 9, figs. 9, 10.—Millett Journ. Roy. Micr. Soc., 1898, p. 265, pl. 5, figs. 9–12.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 296, pl. 41, fig. 4.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 119.

Spiroloculina milletti Wiesner, Archiv. Prot., vol. 25, 1912, p. 207.

Description.—Test more or less compressed, the chambers closely adjacent or even a little overlapping, numerous, of about even diameter throughout, usually somewhat angular in transverse section, in adult specimens the last-formed chamber with an acute periphery, that of the preceding chamber square or even somewhat concave, apertural end of the chamber somewhat produced, with a distinct tubular neck and occasionally a slightly phialine lip, the aperture rounded, with a single bifid tooth the projections of which are at right angles to the main plate; surface smooth and shining, white.

Length, about 1 mm.

Distribution.—The following are the existing records for this species in the North Pacific: Honolulu coral reefs, *Challenger* station 260A, in 40 fathoms (Brady); "collected in the Gulf of Tokio" (Flint); off the Hawaiian Islands, *Albatross* D4017, in 305 fathoms, (Bagg).

The only material which I have had referable to this species is from off the Hawaiian Islands, *Nero* station 2070 in 285 fathoms.

This species, which, as described by Wiesner, is evidently different from the *S. nitida* of d'Orbigny, seems to be a tropical one. From the notes of Millett there seems to have been two distinct things in the Malay material, the figured "wild-growing" forms being distinctly stated by Millett to have cylindrical chambers.

SPIROLOCULINA NUDA, new species.

Plate 5, fig. 5.

Description.—Test in front view elongate, tapering toward the ends, in end view with the periphery of the chambers much convex, edges rounded, chambers with the inner margin slightly raised, in some specimens usually smooth, the sutures very indistinct, the wall often devoid of all sculpture or trace of sutures, apertural end somewhat extended, forming a slender cylindrical neck ending in a broad flaring lip, area at the base of the neck often concave, the sides of the chamber at this point being slightly carinate, giving a channeled appearance to the region; aperture small, circular, with a single bifid tooth; wall white, dull.

Length of largest adult specimen, 2 mm.

Distribution.—Type-specimen (Cat. No. 9154, U.S.N.M.) from *Nero* station 2070 in 285 fathoms off the Hawaiian Islands; other specimens from *Nero* 2037 in 55 fathoms, Waimea Bay, Hawaiian Islands and *Albatross* H3007 in 323 fathoms in the same general region.

This is a peculiar species and a rather delicately lined one, the rather long tapering neck with the channeling at the base being unusual even in this genus. The dull white exterior, chalky in appearance, with its lack of defined lines either of chambers or of ornamentation, also is noteworthy. Outside the region of the Hawaiian Islands it was not met with in the North Pacific material.

SPIROLOCULINA COSTIFERA, new species.

Plate 6, figs. 1–3.

Description.—Test large, planospiral, chambers few in number, the early ones close coiled, later ones with the tip of the apertural end standing away from the previous chamber, the next chamber added often not filling the gap thus made and in the adult not reaching to the base of the preceding chamber, sutures indistinct; surface of the test with a few longitudinal coarse costae, running the whole length of the chamber; apertural end of the chamber produced to form an elongated neck which has a well-developed phialine lip and a single tooth on the inner margin of the aperture which is flattened on the inner side; wall except for the costae smooth, white, dull.

Diameter, up to 3.5 mm.

Distribution.—Type-specimen (Cat. No. 9155, U.S.N.M.) from *Nero* station 190 in 864 fathoms off Midway Island. The other material was from *Albatross* station H2999 in 549 fathoms off the Hawaiian Islands.

This is a very large and striking species both in its general appearance and in the feature of its partially uncoiling at the end of the chamber in the adult test. This latter feature reminds one of the similar character seen in some of the Quinqueloculine group, but our species is a true *Spiroloculina* as the transverse section here figured shows.

SPIROLOCULINA UNICOSTATA, new species.

Plate 7, figs. 1, 2.

Description.—Test small, one side slightly convex, the opposite side concave, chambers numerous; convex side of test marked by a continuous costa or series of costae, one at the inner border of each chamber, both ends of the last formed chamber produced, the basal portion forming a bluntly rounded projection, the apertural end with a produced cylindrical neck with broadly phialine lip, the aperture circular and, as far as the specimens at hand show, there is no tooth.

Length, 0.30 mm.

Distribution.—Type-specimen (Cat. No. 9156, U.S.N.M.) from *Nero* station 1464 in 891 fathoms off Guam.

This in some ways seems related to such concave species as *S. affixa* Terquem and *S. inaequilateralis* Schlumberger.

SPIROLOCULINA GRATA Terquem.

Plate 7, figs. 3, 4.

Spiroloculina grata Terquem, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 55, pl. 5, figs. 14*a*–15*b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 155, pl. 10, figs. 16, 17.

Description.—Test in front view rhomboid oval, the extremities somewhat produced, giving an angular appearance to the test, in end view with the sides parallel, the periphery well rounded; chambers long and slender, cylindrical, circular in transverse section, the surface marked by oblique longitudinal costae; apertural end of the chamber produced to form a tapering neck, circular in transverse section; the aperture circular with a single tooth on the inner margin; surface of the test usually finely papillate as seen with higher magnifications; wall often brownish, translucent.

Length, usually less than 1 mm.

Distribution.—Brady records this species from a single North Pacific locality, *Challenger* station 260A in 40 fathoms off the coral reefs of Honolulu, Hawaiian Islands. Bagg records it also from the same region at a single *Albatross* station D4017 in 305 fathoms.

In the *Nero* material it has occurred at a number of stations in the vicinity of the Hawaiian Islands, especially about Waimea Bay. It also occurred in the *Nero* dredgings from Guam. Off the southern coast of Japan it has occurred a few times in the shallower warmer waters in the southern part, especially *Albatross* H4881 in 316 fathoms in Colnett Strait. From the North Pacific Exploring Expedition, Captain Rodgers, there are specimens from Gaspar Straits.

The following variety seems worthy of notice:

SPIROLOCULINA GRATA Terquem, var. ANGULATA, new variety.

Plate 7, fig. 5.

Spiroloculina grata H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 10, figs. 22, 23.

Spiroloculina nitida (Striate variety) Millett, Journ. Roy. Micr. Soc., 1898, p. 266.

Description.—Variety differing from the typical in having the chambers angular instead of circular in transverse section and the costae parallel to the peripheral margin of the chamber instead of oblique as in the typical, in extreme forms with the periphery having a decided keel.

Distribution.—Type-specimen (Cat. No. 9157, U.S.N.M.) from Cebu, Philippines, collected by Dr. E. A. Mearns. Specimens also occurred in shallow water about the Hawaiian Islands in Waimea Bay and off Honolulu.

The figures given by Brady and referred to here, especially figure 23, is very much like that figured here. Millett notes that most of the Malay Archipelago material was of this form.

Both the typical form and the variety seem to be characteristic of shallow water in the Tropics, especially off coral reefs.

SPIROLOCULINA ARENARIA H. B. Brady.

Spiroloculina arenaria H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 153, pl. 8, fig. 12.

Description.—"Test oblong or oval, complanate; extremities obtusely angular or slightly rounded, peripheral edge rounded; segments few and broad, indistinct externally. Aperture small, circular, with milioline tongue; situated in a slightly produced shelly neck. Exterior sandy; length, one-fifteenth inch (1.7 mm.)."

Distribution.—From Brady's account of this species it is one of those limited to the East Indian region, occurring from Torres Strait northward to the Philippines. In the North Pacific the only record is from the *Challenger* station in the Philippines in 95 fathoms.

Genus PLANISPIRINA Seguenza, 1880.

Planispirina SEGUENZA, Atti R. Accad. Lincei, ser. 3, vol. 6, 1880, p. 310 (Type *P. communis* Seguenza).—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 193 (part).

Description.—Test planospiral, chambers in the later growth often more or less involute, concealing the early development, which consists of an oval proloculum, followed by the typical *Cornuspira*-like second chamber, in turn followed by several chambers gradually becoming shorter, those of the adult being less than a half coil in length, usually three or four necessary to make a complete coil.

PLANISPIRINA SPHAERA (d'Orbigny).

Plate 19, fig. 1.

Biloculina sphaera D'ORBIGNY, Voy. Amer. Merid., 1839, "Foraminiferes," p. 66, pl. 8, figs. 13–16.—H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 466, pl. 48, figs. 1*a*–*b*.; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 141, pl. 2, figs. 4*a*, *b*.—SCHLUMBERGER, Feuille des Jeunes Naturalistes, vol. 13, pl. 2, fig. 3.—GÖES, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 84.

Planispirina sphaera SCHLUMBERGER, Mém. Soc. Zoöl. France, 1891, p. 190, text figs. 45, 46.

Description.—Test globular, smooth, two chambers only visible in the adult, the last formed chamber making up nearly all the visible portion of the test, the penultimate chamber represented in the adult by a small protuberant circular area not covered by the last formed chamber; chambers arranged planospirally, three chambers necessary to complete a coil; aperture in the younger specimens V-shaped, in older ones becoming a complex series of irregular narrow openings not raised or but slightly above the general surface of the test.

Diameter, up to 4 mm.

Distribution.—Göes records this species from the *Albatross* material off the western coast of America at depths of 700 and 1,300 fathoms, stations not given. Material in the Göes collection from *Albatross* D3400 in 1,322 fathoms labeled this species by Göes proves upon examination to be rather *Biloculina globulus* Bornemann. In the same collection, however, there is a series of Atlantic specimens which are *P. sphaera* (d'Orbigny). I have had material from *Nero* station 2070 in 258 fathoms off the Hawaiian Islands and *Albatross* D5056 in 258 fathoms, Suruga Gulf, Japan. These latter were very large.

Genus VERTEBRALINA d'Orbigny, 1826.

Vertebralina D'ORBIGNY (Type *Vertebralina striata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 283.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 186.

Description.—Test with the early chambers planospiral, at least from external appearances, later ones becoming rectilinear; wall porcellanous, imperforate, usually ornamented by striations or costae; aperture a long narrow slit either at the outer end of the chamber or somewhat laterally placed; typically with a definite lip.

According to the distinctions made by d'Orbigny this genus included species which had the early chambers arranged in a planospiral manner, later becoming uniserial and uncoiled. This distinction has not been strictly adhered to and it has become not unusual to find either this genus or *Articulina* used for both. Certain of the forms assigned to *Vertebralina* do have an external resemblance to a planospiral condition in the young, but like *Hauerina* are really milioline.

The number of species is very small, mostly known from recent material.

VERTEBRALINA STRIATA d'Orbigny.

Plate 22, figs. 3, 4.

Vertebralina striata D'ORBIGNY, Ann. Mag. Nat. Hist., vol. 7, 1826, p. 283, No. 1; Modèles, No. 81.—WILLIAMSON, Recent Foram. Great Britain, 1858, p. 90, pl. 7, figs. 196*a*, *b* [197, 198].—CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 72, pl. 5, figs. 17–25.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 32, pl. 1, fig. 1.—BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 187, pl. 12, figs. 14–16.—EGGER, Abhandl. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 243, pl. 3, figs. 33, 34.—MILLETT, Journ. Roy. Micr. Soc., 1898, p. 607, pl. 13, fig. 1.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 48, 1904, pt. 2, No. 5, p. 18; vol. 54, pt. 3, 1910, No. 16, p. 6.—CHAPMAN, Journ. Quekett Micr. Soc., ser. 2, vol. 10, 1907, p. 125.

Description.—Test compressed, slightly trochoid, early portion close coiled, increasing rapidly in diameter, last formed chambers in adult becoming uniserial, broadly expanded, the sutures strongly curved, slightly depressed, surface ornamented by fine longitudinal striae; aperture elongate, irregular, the lip on one side being shorter than on the other, making the aperture really on the ventral side of the test, lip smooth, ends rounded and not projecting.

Length, up to 1.2 mm., usually less.

Distribution.—Brady records this species in one of his tables from off Honolulu, Hawaiian Islands, in 40 fathoms. I have had material from several *Nero* stations near the Hawaiian Islands, 2034 in 175 fathoms; 2037 in 55 fathoms; 2039 in 24 fathoms; 2071 in 271 fathoms; and 2074 in 22 fathoms. Most of Bagg's material from this region was from deeper water, which probably accounts for its nonoccurrence in his report.

The trochoid arrangement of the chambers in the typical species, *V. striata,* and its aperture on the ventral side of the test make it very different from *V. insignis,* which is in these two points very unlike the generic characters, and it may be questioned whether they really belong together.

VERTEBRALINA INSIGNIS H. B. Brady.

Plate 22, figs. 1, 2.

Vertebralina insignis H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 187, pl. 12, figs. 9–11.—Flint, Rept. U. S. Nat. Mus., 1897 (1899), p. 302, pl. 47, fig. 4.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 123.

Description.—"Test compressed, planospiral, subquadrangular, nearly symmetrical bilaterally; margin angular or partially carinate. Segments few, more or less triangular in outline, embracing the three segments of the final convolution (with or without a single additional or nonspiral segment) forming almost the entire visible shell. Surface decked with exogenous costae, either distinct or in some parts combined so as to form an irregular reticulated ornament. Aperture a long bordered slit on the median line of the outer face of the terminal chamber.

"Length, one twenty-fifth inch (1 mm.)."

Distribution.—Bagg records this rare species from *Albatross* station H4694 in 865 fathoms off the Hawaiian Islands. I have examined Bagg's specimen from this station and agree with him in the determination. The specimen has a median aperture and the reticulated ornamentation mentioned by Brady, but not nearly as definitely shown in his figures as is the case in this specimen.

The finding of this species seems all the more remarkable as Bagg did not record *V. striata*, which has proved not to be uncommon about the Hawaiian Islands, as shown by the *Nero* material which I have examined.

Genus NODOBACULARIA Rhumbler, 1895.

Nubecularia (part) Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 455.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 135.

Nodobacularia Rhumbler, Nach. Ges. Wiss. Gottingen, 1895, p. 87 (Type *N. tibia* (Jones and Parker)); Zool. Jahrb., Abteil Syst., vol. 24, 1907, p. 37.

Description.—Test composed of a proloculum and second *Cornuspira*-like chamber, usually directly followed by a linear series of subcylindrical chambers; test imperforate, calcareous.

This genus apparently most common in the warm, shallow tropical seas is a very simple one developed from a *Cornuspira*-like early development. Most of the figured specimens seem to be megalospheric, and the microspheric form might possibly show developmental stages lacking in the megalospheric form of the species.

NODOBACULARIA TIBIA, (Jones and Parker).

Plate 8, figs. 1, 2.

Nubecularia tibia Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 455, pl. 20, figs. 48–51.—H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 52, pl. 8, figs. 1, 2; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 135, pl. 1, figs. 1–4.

Description.—Test composed of a globular proloculum followed, at least in the megalospheric form, by a second *Cornuspira*-like chamber a half coil in length, in turn followed by a series of two or three or more usually pyriform or subcylindrical chambers, the basal end being usually the broadest, tapering gradually to the apertural end; aperture simple, rounded occasionally with a somewhat thickened lip.

Length, usually less than 1 mm.

Distribution.—Among other localities Brady mentions the following *Challenger* records for the North Pacific: off the Philippines in 95 fathoms, and Inland Sea of Japan, 15 fathoms, not common.

NODOBACULARIA IRREGULARIS Rhumbler.

Plate 8, fig. 3.

Nodobacularia irregularis Rhumbler, Zool. Jahrb., Abteil Syst., vol. 24, 1907, p. 38, pl. 2, fig. 15.

Description.—Test composed of an oval proloculum with a second, *Cornuspira*-like chamber a half coil in length, with the following chambers irregularly pyriform, extending back and on one side at least covering the distal portion of the previous chamber, apertural end tapering; wall smooth, aperture in later chambers complex, with a pore plate with numerous pores in addition to which there may be secondary apertural openings, usually near the outer angle of the base of the chamber but irregularly placed.

Length, 0.7 to 0.8 mm.

Distribution.—Rhumbler described this species from Laysan.

As noted by the author of the species this is somewhat intermediate between *Nodobacularia* and *Nubecularia* except that the chambers are uniserial. The irregularity and secondary openings are somewhat more like *Nubecularia.*

Genus NUBECULARIA Defrance, 1825.

Nubecularia Defrance, Dict. Sci. Nat., vol. 35, 1825, p. 210 (Type *N. lucifuga* Defrance).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 133.

Description.—Test typically coiled, planospiral, free or attached, consisting of an oval proloculum and second *Cornuspira*-like chamber of variable length, followed by several chambers irregular in shape and arrangement, but usually more or less distinctly planospiral, apertures one or more, irregularly arranged, wall smooth, roughened, or with incorporated sand grains.

As a rule the species of this genus are typical of the shallow waters of tropical and subtropical seas, attached to various objects or becoming free. The test is porcellanous and imperforate and the early stages show it to be a degenerate type from perhaps different sources within the family. The test, as is the case in so many attached forms, becomes highly irregular.

NUBECULARIA LUCIFUGA Defrance.

Plate 8, fig. 6.

Nubecularia lucifuga DEFRANCE, Dict. Sci. Nat., vol. 25, 1825, p. 210, Atlas Zooph., pl. 44, fig. 3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 134, pl. 1, figs. 9–16.—MILLETT, Journ. Roy. Micr. Soc., 1898, p. 261, pl. 5, fig. 7.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 8, pt. 2, No. 5, 1904, p. 2, pl. 2, figs. 1–4.—RHUMBLER, Zool. Jahrb., Abteil Syst., vol. 24, 1907, p. 39, pl. 2, fig. 16.

Description.—Test free or attached, composed of the usual early planospiral chambers, after which the chambers become irregularly planospiral or highly irregular; wall porcellanous and imperforate; aperture one or several, rounded, irregularly placed, sutures in later chambers often indistinct.

Distribution.—Rhumbler records this species from Laysan. A figure after Rhumbler is here given (pl. 8, fig. 6). While the specimens are attached chambers are built with no calcareous floor, but as soon as they become free complete chambers are built and a secondary calcareous growth covers the remainder of the previously attached portion of the test.

NUBECULARIA BRADYI Millett.

Plate 8, figs. 4, 5.

Nubecularia inflata H. B. BRADY (not *Nubecularia inflata* Terquem), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 135, pl. 1, figs. 5–8.

Nubecularia bradyi MILLETT, Journ. Roy. Micr. Soc., 1898, p. 261, pl. 5, fig. 6.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 48, No. 5, 1904, p. 3.—RHUMBLER, Zool. Jahrb., Abteil Syst., vol. 24, 1907, p. 40, pl. 2, figs. 17–19.

Description.—"Test consisting of a few, misshapen, inflated segments, irregularly combined; aperture either single and simple, or more usually, consisting of a number of rounded orifices variously placed.

"Diameter, one-thirtieth inch (0.84 mm.) more or less."

Distribution.—The first of the localities mentioned for this species by Brady is off Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. Rhumbler has the species from shore sands from Laysan. The description is from Brady, and the figures from Brady and Rhumbler.

Subfamily 2. QUINQUELOCULININAE.

Test in the adult or in the early development of the test, at least in the microspheric form with the chambers a half coil in length and added in planes 144° from one another, five planes being necessary to complete a cycle before a new chamber is added directly above one of the previous ones, aperture at this stage at least alternately at opposite poles of the test.

While all the microspheric specimens of this group have the typical quinqueloculine development at least in the young, the adult characters in various genera have a wide range from the three planes, 120° apart in *Triloculina,* the two planes 180° apart in *Biloculina* to the uniserial development of *Articulina,* the flattened form of *Hauerina,* etc. All, however, have a similar quinqueloculine development at least in the young of the microspheric form.

Genus QUINQUELOCULINA d'Orbigny, 1826.

Quinqueloculina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 301. (Type *Q. seminulum* (Linnaeus).

Description.—Test in the young with the usually oval proloculum and short, *Cornuspira*-like second chamber, followed by the adult character both in the microspheric and megalospheric forms of the species. This adult character consists of chambers a half coil in length added successively in planes 144° apart, five chambers being thus added before a cycle is completed and a new chamber added in the plane of the fifth preceding chamber and covering it exteriorly. The chambers are thus 72° from one another, but each as added is 144° from its immediately preceding one in the series; aperture typically elongate with a simple tooth and with little or no elongation of the neck except in certain of the more complex species.

From a study of the development of various genera of this subfamily it seems that d'Orbigny's characterization of the various genera *Quinqueloculina, Triloculina, Biloculina,* etc., was very strictly in accord with the actual relationships in the group. The later studies by Munier-Chalmas and Schlumberger show that the quinqueloculine development not only has a distinct generic significance but that it is phylogenetically very important in the development of the various generic types of this subfamily. A rather full discussion of the matter has already been given in the introductory pages and need not be repeated here.

QUINQUELOCULINA AGGLUTINANS d'Orbigny.

Plate 9, fig. 1.

Quinqueloculina agglutinans D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 168, pl. 12, figs. 11–13.

Miliolina agglutinans SIDDALL, Cat. Brit. Rec. Foram., 1879, p. 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 180, pl. 8, figs. 6, 7.

Description.—Test free, in the adult with five visible chambers, basal portion porcellanous, exterior rough, with agglutinated particles, usually calcareous, aperture oval, with a bifid tooth.

Length rarely more than 1 mm.

Distribution.—There seems to be no available published records from the North Pacific. I have had material definitely referable to this species from but three stations—off Japan; *Albatross*, D4874, in 66 fathoms and D4970 in 500 fathoms; and from Hongkong.

QUINQUELOCULINA ALVEOLINIFORMIS, (H. B. Brady).

Miliolina alveoliniformis H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 52; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 181, pl. 8, figs. 15–20.

Description.—Test elongate, fusiform, composed of numerous chambers, long and narrow, five to eight visible from the exterior; wall in young specimens thin and porcellanous, in adults covered with sand grains; aperture composed of numerous pores or radiate, often indistinct.

Length, up to 2.5 mm.

Distribution.—From the known records of this species it is clearly one of warm shallow waters, especially characteristic of coral reefs. The only published record for the North Pacific is that given by Brady in the *Challenger* Report, coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms. I have found the species fairly common in shallow-water material from Gaspar Straits, the largest fully 2.5 mm. in length, and from Apra Bay, Guam.

The relation of this species to others of the genus is not entirely apparent. The aperture is rather different from the typical *Quinqueloculina*, being usually cribrate, like *Hauerina*. A few other species, however, have this character. In some specimens the arrangement is quinqueloculine, but in the very largest ones this is somewhat obscured by the fact that the width of the chambers does not increase correspondingly with the length, and as a result the earlier chambers are left exposed and more than five chambers are visible. The specimens in the material I have had have often been worn or broken, and excellent material for detailed study has been rare.

QUINQUELOCULINA AGGLUTINATA, new species.

Plate 9, fig. 2.

Description.—Test free, five visible chambers in the adult, wall on the exterior made up of agglutinated sand grains, with a smoothly finished exterior, chambers somewhat angled, the angles rounded, outer margin slightly convex, chambers broadest toward the base, tapering slightly toward the apertural end, neck not distinctly developed, flush with the base of the preceding chamber, aperture oval, with a simple flattened tooth, rather broad, with truncate or slightly rounded at the outer end.

Length, 0.60 to 0.90 mm.

Distribution.—Type-specimen Cat. No. 9158, U.S.N.M., and paratypes, all from a single station, full data not given, the material simply marked "Off Alaska." The species reminds one somewhat of *Q bidentata* of d'Orbigny, but the apertural characters in all the specimens examined were very constant and decidedly different from that species. Perhaps it most resembles the subarctic form figured by Goës[1] under the name *Miliolina agglutinans*.

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[1] Kongl. Svensk. Vet. Akad. Handlingar, vol. 25, 1894, pl. 19, figs. 848i–l.

QUINQUELOCULINA SUBARENARIA, new species.

Plate 10, figs. 1, 2.

Description.—Test one and one-half times as long as wide, chambers distinct, sutures slightly depressed, peripheral margin broadly rounded, occasionally almost flattened, sides of chambers flattened or slightly concave, wall of the peripheral face smooth and polished, the sides arenaceous to the sutures, line between the side and peripheral faces usually somewhat irregular, apertural end slightly exserted, with a slight nearly circular neck, with a thin lip and a simple tooth, basal end of the last-formed chamber extending prominently beyond the preceding ones.

Length, up to 1.75 mm.

Type-specimen.—(No. 9159, U.S.N.M.) from 13 fathoms off Singapore. There were numerous other specimens of this species, with the type all of the same character.

QUINQUELOCULINA ARENACEA (Rhumbler).

Plate 17, figs. 3, 4.

Miliolina arenacea Rhumbler, Zool. Jahrb., Abteil. Syst., vol. 27, 1907, p. 43, pl. 3, figs. 24, 25.

Description.—Test free, elongate, elliptical, length about twice the width, usually quinqueloculine chambers narrow, so that sometimes as many as 6 or 7 chambers are visible from the exterior; the apertural end sharply contracted into a short neck at the end of which is the slitlike aperture; wall exteriorly composed of calcareous granules, hiding the calcareous basal shell material.

Distribution.—This species was described by Rhumbler from numerous specimens in the shore sands of Laysan.

This species differs from *Q. alveoliniformis*, which is somewhat resembles, in the simple aperture, the more elliptical form pointed ends and thickly set grains on the exterior.

QUINQUELOCULINA SEMINULUM (Linnaeus).

Plate 11, fig. 2.

Serpula seminulum Linnaeus, Syst. Nat., ed. 12, 1767, p. 1264, No. 791; 13th (Gmelin's) ed., 1788, p. 3739, No. 2.

Quinqueloculina seminulum d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 303, No. 44.

Miliolina seminulum Williamson, Rec. Foram. Great Britain, 1858, p. 85, pl. 7, figs. 183–185.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 157, pl. 5, figs. 6*a–c*.

Description.—Test somewhat longer than broad, smooth, peripheral margins rounded, sutures distinct, apertural end not exserted, aperture fairly large, oval, with a simple tooth becoming bifid at the free end.

Length, up to 1.5 mm.

Distribution.—Specimens referable to this species were found at numerous localities in the western Pacific off Japan, Guam, and the Philippines. Brady records it in 40 fathoms off the coral reefs of Honolulu, Hawaiian Islands, and from two *Challenger* stations in deep water 244 in 2,900 and 253 in 3,125 fathoms.

The synonymy of this species is very large and very difficult to unravel, as the name has been used to include almost all sorts of smooth quinqueloculine forms. It is here used in the sense used by Brady and other British writers.

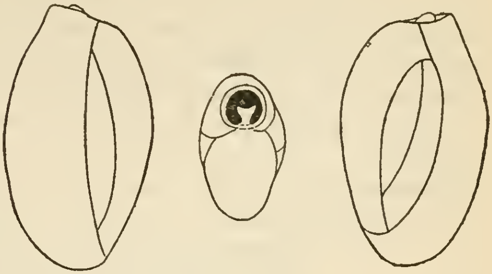

FIG. 29.—QUINQUELOCULINA SEMINULUM (LINNAEUS). × 25. OUTLINES OF SPECIMEN FROM NERO STATION 1466 OFF GUAM.

QUINQUELOCULINA PROCERA (Goës).

Plate 19, fig. 2.

Miliolina procera GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 82, pl. 7, figs. 7–9.

Description.—Test comparatively large, thick, wall heavy, smooth, chambers tumid, distinct, sutures distinct but not deep, apertural end not at all exserted, aperture slightly depressed below the general surface, consisting usually of a transverse narrow slit more or less angled in a zigzag fashion, the lip but slightly developed and usually no definite tooth apparent.

Length, up to 2.40 mm.

Distribution.—Goës described this species from the eastern tropical Pacific, *Albatross* station 3,407 in 885 fathoms. I found abundant specimens of apparently the same species from *Albatross* station 3346 off the west coast of the United States.

This is a large and striking species and seems to be a distinct one, and in the Pacific at least, so far as material has shown, seems to be confined to the western coast of America.

QUINQUELOCULINA VENUSTA, Karrer.

Plate 11, fig. 1.

Quinqueloculina venusta KARRER, Sitz. Akad. Wiss. Wien, vol. 57, 1868, p. 147, pl. 2, fig. 6.

Miliolina venusta H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 162, pl. 5, figs. 5, 7.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 2, pl. 11, figs. 2, 3.—CHAPMAN, Journ. Roy. Micr. Soc., 1891, p. 573, pl. 9, figs. 5, 6.—EGGER, Abhandl. köng. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 235, pl. 2, figs. 56–58.

Description.—Test fusiform, quinqueloculine; one and one-half times as long as wide; chambers prominently triangular in transverse section, the peripheral margin bluntly angular, wall smooth; sutures not greatly depressed; apertural end somewhat produced to form a short contracted neck, nearly circular in section with a thickened lip and short simple tooth.

Length, usually less than 1 mm., one specimen nearly 2 mm. in length.

Distribution.—All the material I have had of this species in the North Pacific is from the region of the Hawaiian Islands, from three different sets of dredgings—*Albatross* H2922 in 268 fathoms, *Nero* 2034 in 175 fathoms, 2071 in 271 fathoms, and *Tuscarora* ½, in 206 fathoms, latitude 21° 10′ N.; longitude 158° 04′ W.

As a rule this species seems to be found in water of considerable depth and here it was not found in the shallow water of the same region. Brady records it from the North Pacific but without station.

QUINQUELOCULINA VULGARIS d'Orbigny.

Plate 11, fig. 3.

Quinqueloculina vulgaris D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 302, No. 33.—SCHLUMBERGER, Mém. Soc. Zool. France, 1893, p. 207, text figs. 13, 14, pl. 2, figs. 65, 66.

Description.—Test short and stout, about as long as wide, in front view orbicular, chambers in transverse section roughly triangular, the periphery bluntly angled, sides straight or slightly convex; sutures distinct, wall smooth; apertural end not contracted or produced; aperture elongate, narrow, with a tooth bifid at the tip, in front view projecting slightly above the border of the aperture.

Length, averaging about 0.75 mm.

Distribution.—This has seemed to be one of the most common species of this genus in the North Pacific, being found about the Hawaiian Islands, off Midway Island, off Guam, and at numerous points about Japan and between Guam and Japan in the *Nero* material especially.

QUINQUELOCULINA AUBERIANA d'Orbigny.

Plate 12, fig. 1.

Quinqueloculina auberiana D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminiferes" p. 167, pl. 12, figs. 1–3.

Miliolina auberiana H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 162, pl. 5, figs. 8, 9.—GOËS, Kongl. Svensk. Vet.-Akad. Handl., vol. 25, 1894, p. 109, pl. 19, fig. 844*a–d*.

Description.—Test in front view oval, nearly as broad as long, in end view roughly triangular, quinqueloculine; chambers stout, roughly triangular in section, the periphery acutely angled, sides convex; apertural end very slightly produced, neck not visibly contracted; aperture elongate oval, with a simple tooth, thickened somewhat at the tip.

Length up to and occasionally slightly exceeding 1 mm.

Distribution.—Specimens closely approximating the figures of d'Orbigny were obtained from *Tuscarora* stations 5/2 in 25 fathoms, latitude 32° 26′ N.; longitude 140° 44′ E. and 60 in 63 fathoms, latitude 21° 14′ N.; longitude 157° 36′ W.; from *Albatross* H3007 in 323 fathoms, off the Hawaiian Islands, and *Nero* 2033 in 249 fathoms in the same region; also from *Albatross* D4878 in 59 fathoms; D5055 in 124 fathoms and D5068 in 77 fathoms, all off Japan.

QUINQUELOCULINA CUVIERIANA d'Orbigny.

Plate 12, fig. 2.

Quinqueloculina cuvieriana D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminiferes," p. 164, pl. 11, figs. 19–21.

Description.—Test clearly quinqueloculine, short and broad; subcircular in front view, chambers sharply angled, the sides convex, the angles with usually two longitudinal costae very close to the peripheral angle, which is almost carinate, remainder of the chamber smooth; no apertural neck developed; aperture a narrow elongate or slightly curving opening, broadening slightly at the farther end, with a simple linear tooth nearly the length of the aperture.

Lenght, about 0.60 to 0.75 mm.

Distribution.—The only specimens referable to this species are from Hongkong in shallow water.

The specimens referred to this species by Brady and Bagg from the Hawaiian Islands lack the distinctive accessory carinal costae and are placed under *Q. lamarckiana* d'Orbigny. The form figured by Millett as *Miliolina cuvieriana* seems to be *Q. disparilis* of the short and more rounded variety described here as *var. curta.* Certainly it has little in common with the acute, almost carinate type of d'Orbigny, although it does have costae. Millett notes that none of the figures since d'Orbigny's, which have been placed under *Q. cuvieriana,* show any traces of the secondary costae which characterize the type.

QUINQUELOCULINA BICOSTATA d'Orbigny.

Plate 13, fig. 1.

Quinqueloculina bicostata D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, p. 195, pl. 12, figs. 8–10.

Description.—Test nearly as broad as long, chambers broad, sutures usually rather indistinct, peripheral margin in the earlier chambers sharply carinate, in adult specimens being bicostate, wall otherwise smooth, concave adjacent to the periphery, inflated near the inner margin, in end view decidedly angled; apertural end slightly if at all produced; aperture nearly circular, with a smooth, slightly raised lip, tooth simple, not prominent.

Length, about 1 mm.

Distribution.—The only material referable to this species is from *Nero* station 1158 in 1,584 fathoms, between Yokohama and Guam.

QUINQUELOCULINA BICORNIS (Walker and Jacob).

Plate 13, fig. 2.

Serpula bicornis WALKER and JACOB, Adam's Essays, Kanmacher's Ed., 1798, p. 633, pl. 14, fig. 2.

Miliolina bicornis WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 87, pl. 7, figs. 190–192.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 171.

Description.—Test about one and one-half times as long as broad, chambers much the broadest at the basal end, tapering gradually to the periphery, chambers with three faces, the peripheral usually flattened or slightly concave, the sides flattened or slightly concave, ornamented with several prominent longitudinal costae, those separating the peripheral and side faces being particularly well developed; basal portion of the chamber usually projecting somewhat and rounded; apertural end produced into a short subcylindrical neck; aperture circular, with a slight lip and a single tooth.

Length, up to 2 mm.

Distribution.—Brady records this species from off the coral reefs of Honolulu, Hawaiian Islands. The only material I have had was from shallow water in Hongkong Harbor.

QUINQUELOCULINA BICORNIS (Walker and Jacob), var. ELEGANS Williamson.

Miliolina bicornis, var. *elegans* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 88, pl. 7, fig. 195.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 171, pl. 6, figs. 9, 11, 12.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 120.

This more slender variety is recorded in Bagg's paper without station from the Hawaiian Islands. An examination of his material shows a specimen of this form from *Albatross* station H4694, but the specimen is too broken to permit of figuring.

QUINQUELOCULINA DISPARILIS d'Orbigny.

Plate 14, fig. 1.

Quinqueloculina disparilis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 302, No. 21.—SCHLUMBERGER, Mém. Soc. Zool. France, vol. 6, 1893, p. 212, pl. 2, figs. 55–57, figs. 21, 22 in text.

Description.—Test somewhat longer than broad, chambers very distinct, polygonal, consisting of an outer peripheral face which is flattened or slightly rounded and ornamented with several longitudinal costae, the side faces meeting the peripheral almost at right angles, flattened or slightly concave, smooth and unornamented, basal end of the final chamber projecting nearly its whole width beyond the remainder of the test; apertural end truncate but without a neck; aperture with a slightly thickened lip and a simple tooth tending to a broadening or even slightly bifid condition at the free end.

Length, a little less than 1 mm.

Distribution.—The typical form of this species has occurred only at *Nero* station 1328, in 871 fathoms, between Yokohama and Guam.

QUINQUELOCULINA DISPARILIS d'Orbigny, var. CURTA, new variety.

Plate 14, fig. 2.

Description.—Variety larger and very much broader than the typical, nearly circular in front view; inner margin of the chambers somewhat convex and overlapping the previous ones.

Length, up to 2 mm.

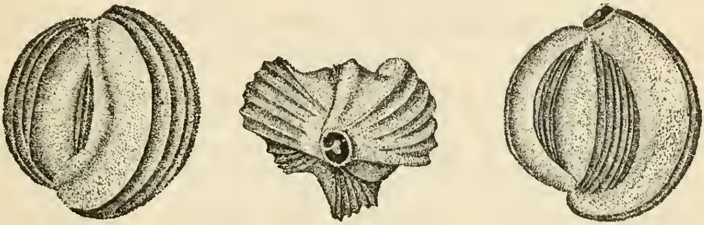

FIG. 30.—QUINQUELOCULINA DISPARILIS D'ORBIGNY, VAR. CURTA, NEW VARIETY. ×18. SPECIMEN FROM "ALBATROSS" STATION 4900, OFF JAPAN.

Distribution.—Type-specimen (Cat. No. 9168, U.S.N.M.) from *Albatross* station D4900, in 139 fathoms, off Japan. At this station this variety was very common, and all the specimens were of this short stout form.

QUINQUELOCULINA COSTATA d'Orbigny.

Plate 15, fig. 1.

Quinqueloculina costata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 301, No. 3.—TERQUEM, Mém. Soc. Geol. France, ser. 3, vol. 1, 1878, p. 63, pl. 6, figs. 3*a*–5*c*.

Description.—Test about twice as long as wide, elliptical or narrowly oval, chambers tumid, peripheral margin broadly rounded, sutures distinct but not deeply depressed, surface ornamented by numerous longitudinal, rather remote lines, apertural and exserted, with a slight neck tapering gradually from the peripheral curve, aperture broadly elliptical, basal end of the chamber broadly rounded, apertural end much darker than the remainder of the test.

Length, about 1 mm.

Distribution.—The only material of this species which I have had is from *Nero* stations 2039 in 24 fathoms and 2041 in 33 fathoms, Waimea Bay, Hawaiian Islands.

QUINQUELOCULINA BOUEANA d'Orbigny.

Plate 15, fig. 2.

Quinqueloculina boueana D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 293, pl. 19, figs. 7–9.

Miliolina boueana H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 173, pl. 7, figs. 13*a–c*.

Description.—Test nearly as broad as long, chambers broad, distinct, sutures depressed, peripheral margin broadly rounded, last formed chamber not exserted at the apertural end, surface ornamented with numerous, distinct, longitudinal costae, aperture nearly circular, lip slightly thickened, with a simple tooth.

Length, usually less than 1 mm.

Distribution.—This species has occurred at *Nero* station 2041 in 33 fathoms in the vicinity of the Hawaiian Islands, *Nero* station 1466 off Guam in 234 fathoms, and at *Albatross* station D4900 in 139 fathoms off the coast of Japan.

QUINQUELOCULINA PARKERI (H. B. Brady).

Plate 15, fig. 3.

"*Quinqueloculina* with oblique ridges" PARKER, Trans. Micr. Soc. London, vol. 6, 1858, p. 53, pl. 5, fig. 10.

Miliolina parkeri H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 46; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 177, pl. 7, fig. 14.

Description.—"Test elongate, subtriangular, quinqueloculine; peripheral margins of the segments sharp, with a tendency to become carinate; the surface of the chambers traversed by somewhat oblique transverse ridges or crenulations.

"Length, one twenty-fifth inch (1 mm.)."

Distribution.—This species seems to be, as noted by Brady, essentially a coral-reef species. In his tables of distribution he includes it from *Challenger* station 260A, in 40 fathoms off the coral reefs of Honolulu, Hawaiian Islands. Bagg also records it from this same region, *Albatross* D4000, in 104 to 213 fathoms, H4566, in 572 fathoms, and H4694 in 865 fathoms. Rhumbler records it from Laysan Island, a single specimen. I have examined Bagg's mounted material from the Hawaiian Islands, and it appears to be typical. In the material I have had from this same region I have found it but once, in material from *Nero* station 2039, in 24 fathoms. Typical specimens occur in shallow water material from Apra Bay, Guam, and from Gaspar Straits.

QUINQUELOCULINA FERUSSACII d'Orbigny.

Plate 19, figs. 3, 4.

Quinqueloculina ferussacii D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 301, No. 18; Modèles No. 32.

Miliolina ferussacii H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 175, pl. 113, figs. 17, *a*, *b*.

Description.—Test elongate, narrow, much drawn out at either end, chambers angular, usually the peripheral face of the later chambers with distinct costae, the last formed chamber with three, the one preceding with a single median one; wall smooth except for the costae; last formed chamber much extended at the apertural end, with a long narrow neck, aperture circular with a simple tooth.

Length, 1 mm. or less.

Distribution.—The species has been recorded from the North Pacific by Brady from *Challenger* station 260A in 40 fathoms from the coral reefs of Honolulu, Hawaiian Islands, and by Rhumbler from Laysan. I have had material from but two stations, both in the vicinity of the Hawaiian Islands, *Nero* 2047, in 217 fathoms, and 2071 in 271 fathoms.

These specimens are of the elongate compressed type, which agree with Brady's figures and with the model given by d'Orbigny. Many of the specimens referred to this species by later authors do not at all agree with the typical as represented by the model.

QUINQUELOCULINA AMYGDALOIDES (H. B. Brady).

Miliolina amygdaloides H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 163, pl. 6, figs. 10, *a*, *b*.

Description.—"Test compressed, elongate-oval with tapering ends; one face nearly flat, the other convex and subangular; periphery sharp. Surface smooth, no external constrictions marking the margins of the chambers. Segments numerous, long and narrow; aperture circular, produced. Shell-wall thin and opalescent.

"Length, one-fiftieth inch (0.5 mm.) or less.

"This is a minute species but very uniform in its adult characters. The shell is exceedingly neatly made, but owing to the flush sutures the segmentation is always obscure. I know of no previously described form with which the specimens can properly be associated; the *Quinqueloculina pygmaea* of Reuss is perhaps the nearest, but the rounded chambers, excavated sutures, and generally larger size sufficiently distinguish that from the present species."

Distribution.—Brady described this species from comparatively shallow water in the vicinity of some of the Islands of the Pacific the only North Pacific one being from *Challenger* station 232 in 345 fathoms, on the *Hyalonema* ground south of Japan.

QUINQUELOCULINA DUTEMPLEI d'Orbigny.

Plate 18, figs. 1, 3.

Quinqueloculina dutemplei D'ORBIGNY, Foram. Foss. Vienne, 1846, p. 294, pl. 19, figs. 10–12.

Description.—Test quinqueloculine, one and at half times as long as wide, chambers sharply angled and carinate peripherally, wall coarsely and longitudinally striate; apertural end somewhat produced, basal end broadly rounded, little if at all extending beyond the previous chamber; aperture rounded with a slightly thickened lip and simple elongate tooth slightly bifid at the tip.

Length, slightly less than 1 mm.

Distribution.—Specimens from *Tuscarora* station 60, in latitude 21° 14′ N.; longitude 157° 36′ W. in 63 fathoms near the Hawaiian Islands seem to belong to this species.

QUINQUELOCULINA BRADYANA, new species.

Plate 18, fig. 2.

Miliolina undosa H. B. Brady (not *Quinqueloculina undosa* Karrer), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 176, pl. 6, figs. 6–8.

Description.—Test stout, usually but slightly longer than broad, chambers angular, more or less plicated laterally, the outer peripheral angle usually sinuous, the early ones very prominently so; apertural end rarely extended to any considerable length, aperture usually narrow with a simple tooth.

Length, about 1 mm.

Distribution.—Brady's material was largely from shallow water material of the Indo-Pacific region. The material I have had has all been from comparatively shallow water about the Hawaiian Islands—type specimens, Cat. No. 9160, U. S. N. M., from *Nero* station 2039 in 24 fathoms and another lot from station 2070 in 285 fathoms.

This species does not seem to be at all identical with the *Q. undosa* of Karrer described from the Miocene of Austria. Brady himself notes various differences, as do later authors.

The figured specimen has the apertural end somewhat broken and therefore does not show clearly the complete apertural conditions.

QUINQUELOCULINA UNDULATA d'Orbigny.

Quinqueloculina undulata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 302, No. 27.—Schlumberger, Mém. Zool. Soc. France, 1893, p. 213, text figs. 23, 24; pl. 1, figs. 53, 54; pl. 2. figs. 60, 61.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 48, No. 5, 1904, p. 13.

Description.—Test irregularly oval in front view, nearly as broad as long, in the young with the chambers very strongly carinate and more or less undulate, sutures indistinct, in the adult becoming more regular; the sutures deeper and distinct, surface ornamented with rather coarse, slightly oblique, longitudinal striations, the chambers also transversely somewhat wrinkled; apertural end but slightly produced; aperture itself long and narrow with a long tooth, bifid at the tip.

Length, up to 1 mm.

Distribution.—The only material which seems to belong to this species is from *Nero* station 2033 in 249 fathoms off the Hawaiian

Islands. The sections figured by Schlumberger are very interesting in showing the smooth early chambers with the gradual development of the ornamentation, first with a single rib then two with a depression and finally in the adult a chamber with numerous ribs and striations on the peripheral portion.

QUINQUELOCULINA RUGOSA d'Orbigny.

Quinqueloculina rugosa D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 302, No. 24.—SCHLUMBERGER, Mém. Zool. Soc. France, 1893, p. 210, text figs. 18, 19, pl. 4, figs. 91–93.

Description.—Test fusiform, quinqueloculine, chambers of the adult quadrangular in transverse section, the periphery flattened and broad, the sides nearly at right angles to the peripheral face; in some cases both periphery and sides somewhat concave; wall slightly rugose, often with fine broken lines; apertural end slightly produced to form a short subcylindrical neck; aperture rounded, with a simple tooth.

Length, usually slightly less than 1 mm.

Distribution.—Specimens of this species were found sparingly in material from about the Hawaiian Islands, *Nero* station 2033 in 249 fathoms, 2036 in 82 fathoms, *Albatross* D4807, in 44 fathoms off Hakodate, Japan, D4900 in the Eastern Sea of Japan; also *Tuscarora* material from Manila Bay, Philippine Islands, and material from Hongkong Harbor.

In its early stages the chambers, as shown in figures given by Schlumberger, are smooth and rounded and show nothing of the adult character. This is the rule for species which are angled or ornamented in the adult and exactly what would be the case in any other group of animals.

QUINQUELOCULINA SUBROTUNDA (Montagu).

"Serpula subrotunda dorso elevato" WALKER and BOYS, Test Min., 1784, p. 2, pl. 1, fig. 4.

Vermiculum subrotundum MONTAGU, Test Brit., 1803, pt. 2, p. 521.

Quinqueloculina subrotunda D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 302, No. 36.—H. B. BRADY, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865, p. 94, pl. 12, fig. 2.

Miliola (*Quinqueloculina*) *subrotunda* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 411, pl. 15, fig. 38.

Miliolina subrotunda H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 168, pl. 5, figs. 10, 11.

Brady records this species from *Challenger* station 260A, in 40 fathoms, coral reefs of Hololulu, Hawaiian Islands, and Rhumbler from both Chatham Island and Laysan.

QUINQUELOCULINA PYGMAEA Reuss.

Quinqueloculina pygmaea Reuss, Denkschr. Akad. Wien, vol. 1, 1850, p. 384, pl. 50, figs. 3*a*, *b*.

Miliolina pygmaea H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 163, pl. 113, figs. 16, *a*, *b*.

Distribution.—To this species Brady refers specimens from the North Pacific from Hongkong Harbor and south of Japan.

QUINQUELOCULINA FEROX (Rhumbler).

Plate 17, figs. 5–7.

Miliolina ferox Rhumbler, Zool. Jahrb., Abteil. Syst., vol. 24, 1907, p. 47, pl. 3, figs. 29–31.

Description.—Test generally oval, quinqueloculine, generally smooth, sometimes with a tendency to longitudinal striations; aperture elongate, slit-like, narrow, tooth longitudinally more or less split up into distinct tooth-like projections.

Length, 0.6 to 0.9 mm.

Distribution.—Rhumbler described this species from shore sand of Laysan where it was frequent.

Typically the projections of the tooth are distinct at the tip as in figure 6, or occasionally they are united again above leaving a series of openings.

QUINQUELOCULINA SPIRALIS, new species.

Plate 20, fig. 1.

Description.—Test elongate, twice as long as broad, quinqueloculine, chambers long and narrow, sutures distinct, peripheral margin bluntly angled, occasionally dividing into two blunt carinae with a peripheral depression; wall smooth; whole test twisted about the longitudinal axis, the chambers each making about a half turn; apertural end somewhat extended, especially on the peripheral edge, but only a slight contraction produced; aperture long and narrow with a straight simple tooth nearly the length of the aperture.

Length, 0.60 mm.

Distribution.—Type-specimen (Cat. No. 9161, U.S.N.M.) from *Nero* station 1466 in 234 fathoms off Guam.

This is a rather striking species in its spirally twisted contour, reminding one somewhat of certain of Terquem's, fossil species from Europe.

QUINQUELOCULINA CULTRATA (H. B. Brady).

Plate 21, fig. 1.

Miliolina cultrata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 45; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 161, pl. 5, figs. 1, 2.—Egger, Abhandl. köng. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 231, pl. 2, figs. 29–31.—Millett, Journ. Roy. Micr. Soc., 1898, p. 269, pl. 6, figs. 11, 12.

Description.—Test compressed, at least twice as long as wide typically, chambers biconvex, the peripheral margin strongly carinate, wall smooth; apertural end considerably extended beyond the rest of the test in a sub-cylindrical slightly tapering neck, with a slight lip; aperture oval or elliptical with the tooth inconspicuous.

Length slightly less than 1 mm.

Distribution.—The records for this species are mainly from the Indo-Pacific region in comparatively shallow water. The only material I have had is from Hongkong Harbor in shallow water.

Although Brady starts his description with "Test Triloculine" the figures he gives are not triloculine, and those of Millett seem to indicate that possibly the species belongs to the genus *Massilina*, for his figure 12, above noted, has the final chambers distinctly in one plane. None of the specimens seem to be at all triloculine, thus substantiating the view already expressed that *Massilina* is a direct derivative from *Quinqueloculina*.

QUINQUELOCULINA MACILENTA (H. B. Brady).

Miliolina macilenta, H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 167, pl. 7, figs. 5, 6.

Description.—"Test complanate, oval or discoidal; margin thin; resembling *Miliolina* [*Quinqueloculina*] in general contour and habit, but having a surface ornament of curved, parallel, longitudinal or somewhat obliquely-set costae.

"Length, one-fortieth inch (0.6 mm.)."

Distribution.—Brady described this species from three Pacific Stations of the *Challenger*, one of which, in 40 fathoms off Honolulu, Hawaiian Islands, is in the North Pacific, the others being in the South Pacific, Nares Harbor, Admiralty Islands, of 17 fathoms, and Humboldt Bay, New Guinea, 37 fathoms.

QUINQUELOCULINA RETICULATA (d'Orbigny).

Plate 16, figs. 1–3.

"*Frumentaria reticulata*" Soldani, Testaceographia, vol. 1, pt. 3, 1795, p. 233, pl. 159, figs. *bb*, *cc*.

Triloculina reticulata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 299, No. 9.

Quinqueloculina reticulata Karrer, Sitz. Akad. Wiss. Wien, vol. 44, 1861, p. 449, pl. 2, fig. 5*a*, *c*.

Miliolina reticulata Parker, Jones, and Brady, Ann. Mag, Nat. Hist., ser. 4, vol. 8, 1871, p. 249, pl. 8, fig. 18.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 177, pl. 9, figs. 2–4.—Egger, Abhandl. köng. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 239, pl. 2, figs. 83,84.—Schlumberger, Mém. Soc. Zool. France, vol. 6, 1893, p. 214, text fig. 25, pl. 2, fig. 62.

Description.—Test chiefly characterized by the reticulate character of the ornamentation consisting of oval depressions arranged in lines lengthwise and diagonally, one side usually flattened; aperture elongated, typically with a long straight tooth occasionally inclined to be bifid at the tip.

Length, up to 1.5 mm.

Distribution.—In general this species is abundant in shallow tropical and subtropical waters, especially of coral reef regions. In the North Pacific Brady records it from Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. In the material I have had it has occurred about the Hawaiian Islands at numerous stations, about Guam, Gaspar Straits, and Hongkong.

It seems very possible that more than one species may be represented in the reticulate series of this genus.

QUINQUELOCULINA [?] SCHAUINSLANDI (Rhumbler).

Plate 8, fig. 7, 8.

Miliolina schauinslandi Rhumbler, Zool. Jahrb., Abteil. Syst., vol. 24, 1907, p. 41, pl. 3, figs. 20, 21.

Description.—Test with the early chambers quinqueloculine, later ones very irregular, in one plane usually; aperture large without teeth but with several, 3–5, or more irregular incurving somewhat pointed projections from the apertural border; wall smooth or variously wrinkled or roughened.

Length, 0.3 to 1.5 mm.

Distribution.—Rhumbler described this species from a few specimens from shore sands of Laysan. The only specimens I have had which seem identical are from *Nero* station 2039, in 24 fathoms, off the Hawaiian Islands.

Rhumbler compares the inwardly curving projections about the aperture to those seen in *Nevillina coronata.* From the Hawaiian specimen and those of *Nevillina* which I have seen the projections of this species seem to be entirely a portion of the lip of the aperture, while the ring of teeth of *Nevillina,* uniting as they do in the center, seem morphologically different and the resemblance only a superficial one.

Genus MASSILINA Schlumberger, 1893.

Quinqueloculina (in part) d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 303.

Massilina Schlumberger, Mém. Soc. Zool. France, 1893, p. 218 (type, *M. secans* (d'Orbigny)).

Description.—Test composed of a globular proloculum followed by a *Cornuspira*-like chamber, making a half coil, these in turn followed by a series of quinqueloculine chambers, in the adult composed of chambers arranged like *Spiroloculina* in a single plane, leaving the center open and the chambers a half coil in length.

This genus, which has already been described in some detail in the early pages, is derived from *Quinqueloculina.*

MASSILINA SECANS (d'Orbigny).

Quiqueloculina secans d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 303, No. 43.—Parker, Jones, and Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 34, pl. 1, fig. 10.

Miliolina secans H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 167, pl. 6, figs. 1, 2.—Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 742, pl. 14, fig. 4.—Goës, Kongl. Svensk. Vet.-Akad. Handl., vol. 25, 1894, p. 112, pl. 20, fig. 856.

Massilina secans Schlumberger, Mém. Soc. Zool. France, 1893, p. 218, text figs. 31–34, pl. 4, figs. 82, 83.—Millett, Journ. Roy. Micr. Soc., 1898, p. 608, pl. 13, fig. 3.

Description.—Test in its early development quinqueloculine, smooth, ovoid in shape, in the adult becoming broader, subcircular, relatively more compressed, the adult chambers often transversely plicated or granular, the periphery of the last-formed one often denticulate; aperture elongate, narrow, with a single tooth, bifid at the tip.

Length, up to 1 mm.

Distribution.—Brady records this species from a single North Pacific station, *Challenger* 260A, Honolulu coral reefs, Hawaiian Islands, in 40 fathoms.

MASSILINA ANNECTENS Schlumberger.

Plate 20, fig. 3.

Massilina annectens Schlumberger, Mém. Soc. Zool. France, 1893, p. 220, text figs. 35–37, pl. 3, figs. 77–79.—Sidebottom, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 48, pt. 2, No. 5, 1904, p. 18, pl. 5, figs. 2–4.

Description.—Test broad, often broader than long, chambers quadrangular in section, periphery flattened or slightly concave, smooth except for occasional sand grains embedded in the wall, making the wall more or less roughened in spots; aperture rounded, with a single bifid tooth.

Length, about 0.8 mm.

Distribution.—The only North Pacific material I have had is from *Nero* station 2039, in 24 fathoms, off the Hawaiian Islands.

MASSILINA CRENATA Karrer.

Plate 20, fig. 2.

Spiroloculina crenata Karrer, Sitz. Akad. Wiss. Wien, vol. 57, 1868, p. 135, pl. 1, fig. 9.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 156, pl. 10, figs. 24–26.—Egger, Abhandl. köng. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 225, pl. 1, figs. 42, 43.

Description.—Test in its early development quinqueloculine, adult chambers in a single plane, in front view subelliptical, nearly as broad as long, compressed; chambers long and narrow, margin crenulate, due to the regular contractions or plications of the chamber in the adult; aperture rounded.

Length, up to 0.60 mm.

Distribution.—This small but attractive species is usually associated with coral-reef conditions in the shallow or comparatively shallow waters of tropical islands. Brady records it from the Pacific under such conditions. The material I have had is from *Nero* stations 2034 in 175 fathoms, 2042 in 55 fathoms, and 2070 in 285 fathoms, off Honolulu, Hawaiian Islands.

This species very evidently belongs to the genus *Massilina* instead of to *Spiroloculina*, as its early development seems to be invariably quinqueloculine, and it is only the last few chambers that are spiroloculine.

Genus ARTICULINA d'Orbigny, 1826.

Nautilus Batsch (part), Conch. des Seesandes, 1791, p. 3.

Articulina d'Orbigny (type, *A. conico-articulata* (Batsch)), Ann. Sci. Nat., vol. 7, 1826, p. 300.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 182.

Vertebralina Parker, Jones, and H. B. Brady (part), Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 22.

Description.—Early chambers usually quinqueloculine or triloculine, later ones in a uniserial arrangement, varying considerably in number according to the species; aperture in the adult a rounded, usually elliptical opening, in a depression with a definite phialine lip.

This genus is clearly a modification from *Triloculina* or *Quinqueloculina*, in which the early development shows clearly its relations to those genera, and the later development is an additional character similar and analogous to the uniserial development in *Bigenerina*, *Clavulina*, *Vaginulina*, etc. Such genera represent a final development along a specialized line, and the same is true here.

In some of the species the uniserial characters become relatively nearly the whole of the test, the triloculine or quinqueloculine portion being but a bulbous basal portion; in other species there is a rather even balance between the two portions. Those showing the greatest relative development of the uniserial portions may be definitely placed as the highest development of the genus.

ARTICULINA CONICO-ARTICULATA (Batsch).

Plate 22, fig. 6.

Nautilus (*Orthoceras*) *conico-articulatus* Batsch, Conch. des Seesandes, 1791, p. 3, pl. 3, fig. 11.

Vertebralina conico-articulata Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 22, pl. 1, fig. 2.—Goës (part), Abhandl. Kongl. Svensk. Vet. Akad. Handlingar, vol. 19, 1882, p. 121, pl. 9, figs. 317, 317*b*; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 88.

Articulina conico-articulata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 185, pl. 12, figs. 17, 18; pl. 13, figs. 1, 2.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 216, pl. 40, figs. 7–9.—Egger, Abhandl. köng. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 224, pl.

3, fig. 2.—Millett, Journ. Roy. Micr. Soc., 1898, p. 511, pl. 12, figs. 9, 10 [??]

Articulina nitida D'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 300, No. 1; Modèles, No. 22.

Description.—Test with the early chambers milioline, forming but a comparatively small part of the completed test, later chambers arranged in a linear series, chambers usually longer than wide, the lip flaring somewhat, nearly circular in cross section; wall with comparatively few costae; aperture nearly circular, with a smooth, flaring lip.

Length, up to 2 mm.

Distribution.—Apparently this species had not been definitely recorded from the North Pacific. The only material I have had is rather poor, from *Nero* station 2037, in 55 fathoms, off the Hawaiian Islands, from *Albatross* station H4829 in the eastern Pacific, and from Hongkong. In all cases the specimens were broken.

ARTICULINA SAGRA d'Orbigny.

Plate 22, figs. 7, 8.

Articulina sagra D'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 160, pl. 9, figs. 23–26.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 184, pl. 12, figs. 22–24.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 89.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 301, pl. 47, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1898, p. 511.—Sidebottom, Mem. and Proc. Manchester, Lit. and Philos. Soc., vol. 48, 1904, No. 5, p. 17, pl. 4, figs. 18–20; text fig. 6.

Vertebralina sagra Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 89.

Description.—Test with the early chambers milioline, later ones, usually two or three in a linear series, flattened, three or four or more times as wide as thick, apertural end broadened, somewhat flaring, curved, giving the appearance of several vertebrae, wall costate longitudinally; aperture narrowly elliptical, with a smooth projecting lip.

Length, up to about 1 mm.

Distribution.—Brady records the species from the coral reefs off Honolulu, Hawaiian Islands, in 40 fathoms. Neither Bagg nor Goës record this species from the Pacific. I have had material from *Nero* station 2071 in 271, fathoms, off the Hawaiian Islands, and from Gaspar Straits, North Pacific Exploring Expedition, Captain Rodgers. The species does not appear to be at all common, as it is in the West Indies, for example. Most of the material I have had was from deep water, however, and this may account for its apparent scarcity, although it should be found in shore sands of the tropical Pacific.

There seems to be some confusion with regard to the development of the species and many various forms have been assigned to it. A study of it from typical localities should help to straighten out these discrepancies.

ARTICULINA SULCATA Reuss [?].

Plate 22, fig. 5.

Articulina sulcata Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 383, pl. 49, figs. 13–17.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 183, pl. 12, figs. 12, 13.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 215, pl. 40, fig. 11.—Egger, Abhandl. köng. bay. Akad. Wiss. München, Cl. ii, vol. 18, 1893, p. 243, pl. 2, fig. 5.—Millett, Journ. Roy. Micr. Soc., 1898, p. 510.

Description.—Test composed entirely of chambers without a linear series, milioline in arrangement; wall with few longitudinal costae; aperture with a flaring lip, projecting beyond the outline of the test, narrowly elliptical.

Length, 0.5 mm.

Distribution.—Brady records this species from off the reefs of Honolulu, Hawaiian Islands, in 40 fathoms. I have had material from *Nero* station 2071 in 271, fathoms, in the same region. The material I have had is very similar indeed to that figured by Brady, but it seems questionable as to whether either Brady's or our material really represent the species figured by Reuss. It seems more as though the recent material might be the young stage of something which had a further development, but material was very rare and too little for comparisons.

Genus SIGMOILINA Schlumberger, 1887.

Planispirina (part) H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 193.

Sigmoilina Schlumberger, Bull. Soc. Zool. France, vol. 12, 1887, p. 118.—(Type, *S. sigmoidea* (H. B. Brady)).

Description.—Test in its early stages quinqueloculine, later developing chambers a half coil in length in two series, with each newly added chamber in a plane more than 180° from the previous one, so that the horizontal plane in section shows a gradual turning about the elongate axis of the test, aperture typically with a single, simple tooth.

This genus is a rather curiously modified form with the increase in angle of addition to more than 180°, the chambers thus being added in an increasing spiral. After the inception of the curved line of addition the angle becomes nearly 180°, but the chambers are added, not directly outside the previous ones, as in other genera, such as *Biloculina* or *Spiroloculina*, but are added constantly at one side, giving the curve to the test in transverse section and exposing a number of chambers on the exterior of both sides.

SIGMOILINA CELATA (Costa).

Plate 24, fig. 1.

Spiroloculina celata Costa, Mem. Accad. Napoli, vol. 2, 1855, p. 126, pl. 1, fig. 14.
Planispirina celata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 197, pl. 8, figs. 1–4.

Description.—Test oval or elliptical in front view, the ends rather pointed; in side view narrow, chambers numerous, two to a convolution, one side of the chamber convex, the other slightly concave and extending back over the previous ones of that side, giving the characteristic double curve to the test; wall on the outside composed of cemented sand grains, somewhat roughened, smooth and calcareous within; aperture transversely placed, often with a short, simple tooth.

Length, usually about 1 mm.

Distribution.—There is a single published record for the North Pacific, that given by Flint, from *Albatross* station 3080, in 93 fathoms, off the coast of Oregon. I have had a considerable number of stations represented in the material at my disposal; from the *Nero* material especially on the line between Guam and Japan. The stations range from 891 to 1,529 fathoms, from the *Albatross* material, about Japan in shallower water 139 to 437 fathoms, and from one *Tuscarora* station 58, in 814 fathoms, latitude 26° 52′ N.; longitude 142° 21′ E.

This species is much more common than the preceding, as a rule occurring in fairly deep water.

SIGMOILINA SIGMOIDEA (H. B. Brady).

Plate 24, figs. 2, 3.

Planispirina sigmoidea H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 197, pl. 2, figs. 1–3, woodcut, fig. 5c.

Description.—"Test free, oblong, with slightly projecting or pointed ends, the two faces unequally convex, peripheral edge thin, and slightly rounded; composed of numerous segments, two to each convolution, arranged on the milioline plan, the aperture alternately at either end of the shell. Segments, seldom exceeding 12 in number, arched longitudinally, and set at the outer margin of the alternate sides, the inner margin of the wall of each segment spreading over one lateral surface of the test, whilst the lateral extension of its successor in its turn covers the opposite side. Aperture, a curved transverse orifice in the prominence at the anterior end of the shell.

"Length, one-thirtieth inch (0.85 mm.)."

Distribution.—There are apparently no published records for this species from the North Pacific. I have had material from but five stations, *Nero* 649 in 762 fathoms, 990 in 859 fathoms, and 1320 in

2,048 fathoms, all in the general region of Guam; *Albatross* D4949 in 110 fathoms and H4882 in 248 fathoms, off Japan.

A transverse section fron Brady shows well the characteristic doubly curving axis of the chambers as seen in the sectioned test.

Genus HAUERINA d'ORBIGNY, 1848.

Hauerina D'ORBIGNY (Type *H. compressa* d'Orbigny), Foram. Foss. Bass. Tert. Vienne, 1846, p. 119.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 190.

Description.—Test compressed with the early chambers milioline, the later and greater portion of the test having the chambers arranged in a planospiral manner, usually in the last formed coil at least with more than two chambers in each whorl, surface smooth or ornamented; aperture of a large number of small pores forming a sieve-like plate, usually much longer than wide.

The Miocene species described by Brady and the type of the genus is a smooth species, with a thicker test than the recent species. It is from the Miocene of the Vienna Basin. Reuss has described a species from the Cretaceous as *Hauerina antiqua*, but it apparently is not a true *Hauerina*.

In recent waters the genus is apparently limited to the warmer portions of the Pacific and Indian Oceans.

HAUERINA BRADYI, new species.

Plate 23, fig. 2.

Hauerina compressa H. B. BRADY (not *H. compressa* d'Orbigny) Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 190, pl. 11, figs. 12, 13.—MILLETT, Journ. Roy. Micr. Soc., 1898, p. 610, pl. 13, fig. 11.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 52, pl. 3, fig. 39.

Description.—Test much compressed, the very earliest ones milioline, later ones becoming spiroloculine and finally in the last formed coil more than two chambers appear, usually three making up a complete coil; wall very finely striate-reticulate, periphery rounded or subcarinate, aperture a sieve-plate the entire height of the chamber, curved, with numerous pores.

Diameter, about 1 mm.

Distribution.—Rhumbler records two specimens of this species from Laysan Island. Otherwise it seems to have been unrecorded from the North Pacific. I have had excellent material, type, Cat. No. 9162 U.S.N.M., from Gaspar Straits (North Pacific Exploring Expedition, Captain Rodgers); from Hongkong; *Nero* stations 2042 in 55 fathoms and 2074 in 22 fathoms, off the Hawaiian Islands.

D'Orbigny figures a much less compressed form with more chambers in the final whorl, a smooth surface, the last formed coil making up a greater portion of the visible test and the milioline portion much less distinct. In his figure of the apertural face there is a single large opening surrounded by numerous papillae, which are probably pores. Our recent species seems to be essentially different from that described by d'Orbigny in all its particulars. It is apparently a species of the tropical Indian and Pacific Oceans, with a possible extension to the Mediterranean from the data given by Sidebottom.[1] His specimens are very interesting and may be but a form of this species, as is suggested by him. Egger[2] records a thicker, more robust form from Mauritius. Millett records the species from the Malay Archipelago.

HAUERINA CIRCINATA H. B. Brady.

Plate 23, figs. 3, 4.

Hauerina circinata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 47; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 191, pl. 11, figs. 14–16.—Rhumbler, Zool. Jahrb., Abteil. Syst., vol. 24, 1906, p. 52, pl. 3, fig. 40.

Description.—"Test nautiloid, thin, complanate; composed of two or three convolutions, the last of which, consisting of six or seven segments, completely incloses those previously formed; segments arched, thin and rounded at their peripheral margins; sutural lines marked by external constrictions. Color milky white, sufficiently translucent to show the outline of the inner whorl of chambers. Aperture consisting of a number of perforations distributed irregularly over the septal face of the terminal segment.

"Diameter, one twenty-fifth inch (1 mm.)."

Distribution.—Rhumbler gives the only record for this species in the North Pacific, two specimens from Laysan Island. Brady's material was from shallow-water dredgings among the islands between Australia and Borneo.

From the figures and description given by Brady it seems as though this species was very different in its essential characters from typical *Hauerina* except in the matter of the aperture. Neither the figure nor the description give any light in regard to the structure and arrangement of the early chambers.

HAUERINA ORNATISSIMA (Karrer).

Plate 23, figs. 1, 5.

Quinqueloculina ornatissima Karrer, Sitz. Akad. Wiss. Wien, vol. 58, 1868, p. 151, pl. 3, fig. 2.—H. B. Brady, Quart. Journ. Micr. Sci., vol. 16, 1876, p. 406.

Hauerina ornatissima H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 192, pl. 7, figs. 15–22.—Millett, Journ. Roy. Micr. Soc., 1898, p. 610.—Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 53.

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[1] Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 48, 1904, No. 5, p. 19, pl. 5, figs. 7, 8, text fig. 8; vol. 54, 1910, No. 16, p. 6.

[2] Abhand. köng. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 244, pl. 3, figs. 9, 10, 23, 24.

Description.—Test compressed, early chambers milioline, later ones either embracing and extending in to the center to hide the previously formed chambers or becoming elongate and more or less encircling the periphery, surface ornamented by strong tranverse or radial crenulations crossed by numerous fine longitudinal striae, aperture consisting of numerous small pores in several linear series extending the full height of the chamber.

Diameter, up to 1.5 mm.

Distribution.—Rhumbler records this species from Laysan Island. This is the only published record for the North Pacific. I have had material from Gaspar Straits (North Pacific Exploring Expedition, Captain Rodgers), and from three *Nero* stations, 2041 in 33 fathoms, 2042 in 55 fathoms, and 2071 in 271 fathoms, all off the Hawaiian Islands.

This seems to be also a species of the Indo-Pacific region and is one of the most beautiful of the whole family of the Miliolidae. It is hard to believe that the specimens figured by Brady with involute chambers and the very open ones are both one species. In the latter it is not unusual to find specimens like that figured by Brady,[1] where the last formed chamber returns to the *Cornuspira*-like condition of its own young and has an unbroken chamber about the entire test.

HAUERINA FRAGILISSIMA (H. B. Brady).

Plate 24, fig. 4.

Spiroloculina fragilissima H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 149, pl. 9, figs. 12–14.

Hauerina fragilissima MILLETT, Journ. Roy. Micr. Soc., 1898, p. 610, pl. 13, figs. 8–10.

Description.—"Test nearly circular, complanate, extremely thin; peripheral edge rounded. Segments numerous, much curved, the later ones in adult specimens nearly semicircular. Shell-wall delicately thin and opalescent, the sutures appearing as conspicuous white lines Aperture cribrate.

"Diameter, one-thirtieth inch (0.8 mm.)."

Distribution.—This species has apparently not previously been recorded from the North Pacific. The only specimen I have seen is one from *Nero* station 2071 in 271 fathoms off the Hawaiian Islands. Brady records it from shallow water about the Society and Fiji Islands and about Borneo, and Millett records it from the Malay Archipelago.

HAUERINA PACIFICA, new species.

Plate 21, fig. 2.

Description.—Test irregularly suboval in front view, early chambers quinqueloculine, later ones nearly in one plane, slightly carinate, otherwise nearly circular in tranverse section, wall smooth, in the last-formed coil usually four chambers required to form the whole volution; aperture without neck or thickened lip, sieve-like, consisting of a circular plate, slightly convex, with numerous pores irregularly arranged.

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[1] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 7, fig. 20.

Length, averaging about 0.75 mm.

Distribution.—Type specimen (Cat. No. 9163, U.S.N.M.) from *Nero* station 2039 in 24 fathoms, off the Hawaiian Islands. It also occurred commonly in material from nearby *Nero* stations, 2040 in 21 fathoms and 2041 in 33 fathoms.

The chambers of this species are not compressed and in many of the specimens are slightly more irregular than in the figured specimen. Specimens were common at all three of the above stations, but were not met with elsewhere. Apparently it is a shallow-water tropical species.

Genus TRILOCULINA d'Orbigny, 1826.

Triloculina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 299 (Type *T. trigonula* (Lamarck)).

Description.—Test in its adult development consisting, as seen from the exterior, of three visible chambers added in planes 120° from one another, the third of each series added in the plane of the third preceding and covering it.

In its development it has been shown that in their microspheric form at least the species of *Triloculina* have a typical quinqueloculine development which precedes the adult triloculine condition. Therefore the young microspheric specimens of *Triloculina* may appear to be quinqueloculine and may possibly be mistaken for species of *Quinqueloculina* except for their association with adult *Triloculina* or possibly developing specific characters early enough to show their true relationships.

TRILOCULINA TRIGONULA (Lamarck).

Plate 25, fig. 3.

Miliolites trigonula LAMARCK, Ann. du Mus., vol. 5, 1804, p. 351, No. 3; Anim. sans Vert., vol. 7, 1822, p. 612, No. 3.

Triloculina trigonula D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 299, No. 1, pl. 16, figs. 5–9; Modèles, No. 93.

Miliolina trigonula WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 83, pl. 7, figs. 180–182.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 164, pl. 3, figs. 14–16.

Description.—Test in the adult with three visible chambers, smooth, the angles of the chambers rounded, whole test slightly longer than wide, in end view rounded triangular, the sides convex; aperture with a rather broad bifid tooth, the angles in end view rounded, in outline flattened.

Length usually about 1 mm.

Distribution.—Brady records a single North Pacific station for this species, *Challenger* station 260A in 40 fathoms on the coral reefs of Honolulu, Hawaiian Islands. Bagg records it from the following five *Albatross* stations in the vicinity of the Hawaiian Islands, D4000 in 104–213 fathoms, D4017 in 305 fathoms, D4025 in 275–368 fathoms, H4568 in 1,274 fathoms, and H4696 in 367 fathoms. In the *Nero* material it has occurred about the Hawaiian Islands at two stations at 2041 in 33 fathoms and 2071 in 271 fathoms. In the *Albatross* material it was recorded off Japan at D4807 in 44 fathoms, D4900 in 139 fathoms, and D5068, Suruga Gulf, 77 fathoms, and in Colnett Strait in 316 fathoms. At one *Tuscarora* station 1/3 it occurred, latitude 27° 7′ N., longitude 142° 7′ E. in 73 fathoms.

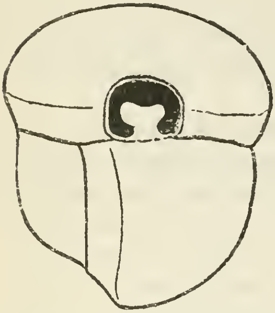


FIG. 31.—TRILOCULINA TRIGONULA (LAMARCK). ×50. OUTLINE FIGURE SHOWING APERTURAL CHARACTERS.

This species is distinguished from the following by the angles of the test which in this species are rounded and the sides convex. Young specimens of *Biloculina* sometimes may be confused with this species but usually apertural or other characters will serve to dis-inguish them as well as the adults of *Biloculina* that they may be associated with.

TRILOCULINA TRICARINATA d'Orbigny.

Plate 25, figs. 1, 2.

Triloculina tricarinata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 299, No. 7; Modeles, No. 94.—H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 446, pl. 48, fig. 3.

Miliolina tricarinata H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 165, pl. 3, fig. 17*a*, *b*.

Description.—Test in the adult with three visible chambers, smooth, the angles of the chambers sharply angled, almost carinate, whole test somewhat longer than wide, in end view triangular, the sides straight; aperture with a narrow bifid tooth.

Length, usually about 1 mm.

Distribution.—Goës records *T. tricarinata* from a single *Albatross* station, 3433 in 1,218 fathoms. Bagg records it from the following four *Albatross* stations near the Hawaiian Islands: D4000 in 104 to 213 fathoms, D4025 in 275 to 368 fathoms, D4174 in 735 to 865 fathoms, and H4694 in 865 fathoms. In the North Pacific material I have examined the species has occurred about the Hawaiian Islands, Midway Island, Guam, and at a number of stations off Japan. These stations range as low as 1,850 fathoms.

As a rule *T. tricarinata* seems to be found in deeper water than its closely allied species, *T. trigonula.*

From one station, D5056 off Japan in 258 fathoms, very large specimens occur with a cruciate aperture similar to the species named by d'Orbigny *Cruciloculina triangularis.* Sufficient material was not available for a study of the young stages to compare them with similar stages of smaller specimens of *T. tricarinata.*

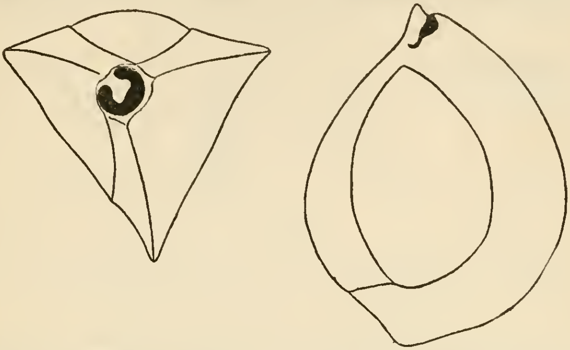


FIG. 32.—TRILOCULINA TRICARINATA D'ORBIGNY. ×13. OUTLINE FIGURE SHOWING THE APERTURAL CHARACTERS.

TRILOCULINA CIRCULARIS Bornemann.

Plate 25, fig. 4; plate 26, fig. 1.

Triloculina circularis BORNEMANN, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 349, pl. 19, fig. 4.

Miliolina circularis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 169, pl. 4, fig. 3*a–c;* pl. 5, figs. 13, 14?—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 82.

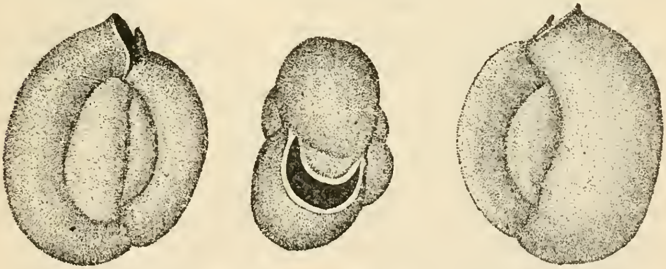


FIG. 33.—TRILOCULINA CIRCULARIS (BORNEMANN). ×36. YOUNG SPECIMEN STILL IN THE QUINQUELOCULINE STAGE FROM HONGKONG HARBOR.

Description.—Test rounded, the three visible chambers in the adult rounded and tumid, sutures distinct, whole test somewhat compressed, the last-formed chamber strongly embracing, wall smooth; aperture a crescentiform narrow slit with a large flattened semicircular tooth.

Length, about 1 mm.

Distribution.—The only definite published North Pacific record for this species seems to be that given by Goës, *Albatross* D3407 in 885 fathoms, off the western coast of tropical America. It has occurred frequently, in the material I have had, off Alaska, about the Hawaiian Islands, near the Galapagos, off Guam, and at numerous stations off Japan. These for the most part have been in comparatively shallow water, ranging from 21 to 316 fathoms.

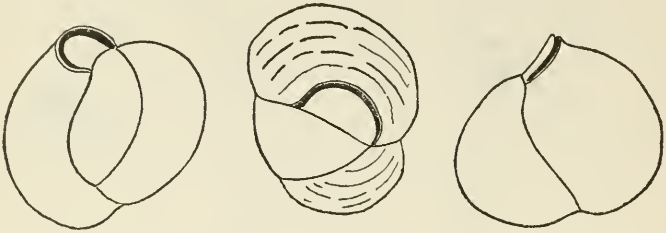


FIG. 34.—TRILOCULINA CIRCULARIS (BORNEMANN). ×13. ADULT SPECIMEN SHOWING THE TRILOCULINE CHARACTER IN THE FULLY DEVELOPED SPECIMEN.

The species seems to be definitely triloculine in its fully developed condition, although as might be expected from its development the early stages are quinqueloculine. The apertural characters are rather striking.

TRILOCULINA CIRCULARIS Bornemann, var. SUBLINEATA (H. B. Brady).

Plate 26, fig. 2.

Miliolina circularis BORNEMANN, var. *sublineata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 169, pl. 4, fig. 7*a–c*.

Description.—"Similar in general contour, disposition of segments, form of aperture, and dimensions to *Miliolina circularis*. Shell thin and often subtranslucent; decorated with a surface ornament of delicate, interrupted, longitudinal striae."

Distribution.—Brady described this variety from a single *Challenger* station, off the Admiralty Islands, on the north coast of New Guinea in 15 to 25 fathoms. The material I have had has come from two *Albatross* stations, D4807 in 44 fathoms and D4900 in 139 fathoms, both off the coast of Japan.

The specimens are very similar to those figured by Brady, most of them even more so than the figured specimen, in which the surface striae are rather more prominent than usual.

TRILOCULINA CYLINDRICA Fornasini.

Plate 17, fig. 10.

Triloculina cylindrica D'ORBIGNY (fide Fornasini), Ann. Sci. Nat., vol. 7, 1826, p. 300, No. 19.—FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 6, vol. 2, 1905, p. 61, pl. 1, figs. 13*a-b*.

Miliolina cylindrica RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24. 1907, p. 50, pl. 3, fig. 36.

Distribution.—Rhumbler records a few specimens from Chatham Island which he refers to this species.

The accompanying figure is from Rhumbler.

TRILOCULINA OBLONGA (Montagu).

Plate 26, fig. 3.

Vermiculum oblongum Montagu, Test. Brit., 1903, p. 522, pl. 14, fig. 9.
Triloculina oblonga D'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 300, No. 16; Modèles, No. 95; in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 155, pl. 10, figs. 3–5.
Miliolina oblonga H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 160, pl. 5, fig. 4*a*, *b*.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 121.

Description.—Test elongate, the adult with three visible chambers, last formed chamber broadest near the initial end and longer than the preceding ones; test in end view triangular, the angles broadly curved, chambers tumid, sutures distinct; wall smooth and unornamented; aperture oval with the tooth simple or narrow and bifid at the tip.

Length, usually less than 1 mm.

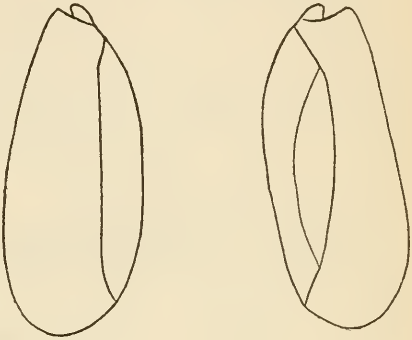


Fig. 35.—Triloculina oblonga d'Orbigny. ×25. Outline of chambers of specimen from "Nero" 2071 in 271 fathoms off the Hawaiian Islands.

Distribution.—Brady has two *Challenger* records of this species from the North Pacific, 260A, in 40 fathons, coral reefs of Honolulu, Hawaiian Islands, and 244 in 2,900 fathoms. Bagg records it at one station, *Albatross,* D4000 in 104 to 213 fathoms off the Hawaiian Islands. The material I have had is distributed as follows: Several *Albatross* and *Nero* stations in the vicinity of the Hawaiian Islands, *Nero* station 1466 in 234 fathoms off Guam, and *Tuscarora* material from Manila Bay, Philippine Islands.

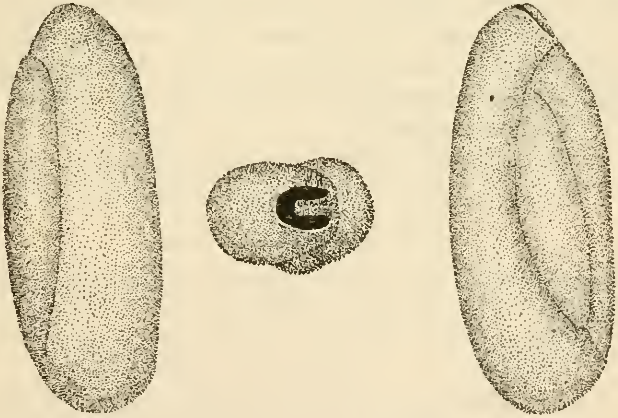


Fig. 36.—Triloculina oblonga d'Orbigny. ×100. Much smaller specimen than that shown in fig. 35, from the same station, but the triloculine characters fully developed.

TRILOCULINA SUBORBICULARIS d'Orbigny.

Plate 21, fig. 3.

Quinqueloculina suborbicularis D'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 302, No. 29.—Schlumberger, Mém. Soc. Zool. France, 1893, p. 215, text figs. 26–28; pl. 2, figs. 63, 64; pl. 3, fig. 67.

Triloculina suborbicularis D'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 300, No. 12; in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 177, pl. 10, figs. 9–11.

Description.—Test suborbicular, much compressed laterally, breadth as great or greater than the length, chambers rounded on the peripheral margin, wall longitudinally striate, earliest ones smooth, aperture subcircular with a flattened lip, tooth simple, semicircular at some distance in front of the aperture itself, apparently on the chamber of the preceding coil.

Diameter, usually less than 1 mm.

Distribution.—Specimens closely approximating those figured by Schlumberger were found at *Nero* station 2074 in 22 fathoms off the Hawaiian Islands. These seem very different from the preceding species. Most of the specimens were apparently still in their quinqueloculine stage.

TRILOCULINA DEPLANATA (Rhumbler).

Plate 17, fig. 2.

Miliolina deplanata Rhumbler, Zool. Jahrb., Abteil. Syst., vol. 24, 1907, p. 42, pl. 3, figs. 23, 23*a*.

Description.—Test triloculine, elongate, elliptical, nearly twice as long as broad, somewhat compressed; sutures very shallow and delicate; aperture an elongate slit, with a single somewhat prominent tooth, slightly raised above the level of the apertural lip.

Length, 0.24 to 0.45 mm.

Distribution.—Rhumbler described this species from a few specimens from Laysan. I have had no material strictly referable to it.

TRILOCULINA LABIOSA d'Orbigny.

Triloculina labiosa D'Orbigny, in De La Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères" p. 157, pl. 10, figs. 12–14.

Miliolina labiosa H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 170, pl. 6, figs. 3–5.

Brady records this species from very deep water in the North Pacific, the tests in the deepest water being completely siliceous. The depths of these stations range from 2,050 to 3,950 fathoms. The same species is recorded by Brady from *Challenger* station 260A in 40 fathoms, coral reefs of Honolulu, Hawaiian Islands.

TRILOCULINA FICHTELIANA d'Orbigny.

Triloculina fichteliana D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 152, pl. 9, figs. 8–10.
Miliolina fichteliana H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 169, pl. 4, fig. 9*a–c*.

Description.—Test in the adult triloculine, somewhat wider than long, the chambers rotund, peripheral margin rounded, sutures deep and conspicuous, wall longitudinally striate, apertural end little if at all produced; aperture rather large, rounded, with a simple tooth and a slightly developed thickened lip.

Length, up to 1.5 mm.

Distribution.—Brady gives among his localities for this species the following from the North Pacific "in dredged sand from the Inland Sea of Japan, 14 fathoms, and from the Chinese Sea."

Although Brady lumps together *T. fichteliana* d'Orbigny and *T. suborbicularis* d'Orbigny, as well as *T. webbiana* d'Orbigny, there seems to be some essential differences between the first and second species at least, and the material I have had from the Hawaiian Islands belongs to the second species.

TRILOCULINA CUNEATA Karrer.

Plate 17, fig. 1.

Triloculina cuneata KARRER, Sitz. Akad. Wiss. Wien, vol. 55, Abteil, 1867, p. 359, pl. 2, fig. 8.
Miliolina cuneata RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24, 1907, p. 42, pl. 3, fig. 22.

Rhumbler records and figures a single specimen from Laysan which he refers to this species. The specimen, the figure of which is reproduced here, shows but two visible chambers on either side, as do certain of Brady's figures referred to this species as a "Biloculine variety." As this single specimen gives little information as to the relation of this species, it is simply recorded here.

TRILOCULINA CRIBROSTOMA (Rhumbler).

Plate 17, fig. 8.

Miliolina cribrostoma RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24, 1907, p. 47, pl. 3, fig. 32.

Description.—Test elongate, about twice as long as wide, elliptical, longitudinally striate; aperture sieve-like.

Length, 0.39 to 0.54 mm.

Distribution.—Rhumbler described this species from numerous specimens found in shore sands from Laysan.

TRILOCULINA TERQUEMIANA (H. B. Brady).

Plate 27, fig. 2.

Miliolina terquemiana H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 166, pl. 114, figs. 1*a*, *b*.

Description.—Test in the adult with three visible chambers, sharply triangular in end view, the angles acute, surface ornamented by longitudinal raised costae; aperture oval with a simple or bifid tooth, narrow.

Length, 0.5 to 1 mm.

Distribution.—This species has not previously been reported from the North Pacific, the *Challenger* collecting it only in shallow water off Ceylon and shore sand from Madagascar. The only material I have had from the North Pacific is from Hongkong Harbor, where several specimens were obtained.

This is similar to *T. tricarinata* with the addition of the costate ornamentation and the difference in the apertural characters, which, in the specimens figured in the *Challenger* report, were not mature.

TRILOCULINA INSIGNIS H. B. Brady.

Plate 27, fig. 3.

Miliolina insignis H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 45; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 165, pl. 4, figs. 8, 10.

Description.—Test in the adult with three visible chambers, the angles of the chambers usually rounded; test somewhat longer than wide, surface ornamented by numerous longitudinal raised costae; aperture nearly circular with a narrow bifid tooth.

Length, about 1 mm.

Distribution.—Brady records the species from a single North Pacific station, *Challenger* 244 in 2,900 fathoms. From the vicinity of the Hawaiian Islands I have found specimens numerous in material from *Nero* 2039 in 24 fathoms, 2040 in 21 fathoms, and 2041 in 33 fathoms.

TRILOCULINA LINNAEANA d'Orbigny.

Plate 27, fig. 4.

Triloculina linnaeana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 153, pl. 9, figs. 11, 13.

Miliolina linnaeana H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 174, pl. 6, figs. 15–20.

Description.—Test typically with three visible chambers in the adult, elongate, tapering toward either end, somewhat compressed, surface ornamented by a few very prominent raised ridges with deep concave depressions between; aperture rounded or slightly elliptical with a single or bifid narrow tooth.

Length, up to 2 mm.

Distribution.—This species is typical of tropical coral reefs in shallow water. Brady under the stations listed in the *Challenger* report gives its occurrence at one North Pacific station, 260A, in 40 fathoms from the Honolulu coral reefs, Hawaiian Islands. Bagg records it from the same islands in deeper water, *Albatross* D4174 in 735–865 fathoms, and H4568 in 1,274 fathoms. Rhumbler records it from shallow water or shore sands of Laysan Island. I have had specimens from several *Nero* stations in the vicinity of the Hawaiian Islands ranging in depth from 21 to 271 fathoms; also specimens were found in shore sand from Midway Island.

Genus ADELOSINA d'Orbigny, 1826.

Adelosina D'ORBIGNY (Type *A. laevigata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 303.—SCHLUMBERGER, Bull. Soc. Zool. France, vol. 11, 1886, p. 544.

Description.—Test in its early portion consisting of a large, laterally compressed proloculum, followed by a second chamber making a complete coil and covering the exterior of the proloculum, later chambers making a half coil, variously ornamented, most frequently with longitudinal costae.

ADELOSINA LAYSANENSIS Rhumbler.

Plate 17, fig. 9.

Adelosina laysanensis RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24, 1907, p. 50, pl. 3, figs. 37, 38.

Description.—Test elongate elliptical, more than twice as long as broad, longitudinally ribbed, about 12 visible on the broad side of the test; apertural end slightly or not at all produced, sometimes contracted; aperture with a single tooth.

Length, 0.10 to 0.18 mm.

Distribution.—This species was described by Rhumbler from shore sands of Laysan, where it was found to be common.

Genus BILOCULINA d'Orbigny, 1826.

Biloculina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 297 (Type *B. bulloides* d'Orbigny).—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 139.

Description.—Test in the adult, composed of chambers one-half coil in length, in planes 180° from one another, only the two chambers last formed visible from the exterior; aperture usually broader than long, typically with a bifid tooth.

As has already been noted in the early pages of the present part, *Biloculina* is a genus derived from *Quinqueloculina* through *Triloculina.* In the complete series of stages shown by the microspheric form of the species after the proloculum and usual second *Cornuspira*-like chamber there is built a series of chambers in planes 144° from one another, five chambers making a cycle, therefore quinqueloculine, followed by another series added in planes 120° from one another, three chambers making a cycle, these in turn followed in adult *Biloculina* by chambers in two planes 180° apart and two chambers making the whole cycle. This, then, is the full life history in the complete series shown in the microspheric form (1) proloculum, (2) *Cornuspira*-like chamber, (3) a series of quinqueloculine chambers, (4) a series of triloculine chambers, and in the adult (5) a series of biloculine chambers.

As the adult conditions are arrived at early in the megalospheric form, and as that is much the more common in usual bottom samples, the early stages of the microspheric form, which in the young might be confused with species of *Quinqueloculina* or *Triloculina,* are relatively rare. (See pl. 27, fig. 1.)

From the standpoint of phylogenetic work it is interesting to note that the early quinqueloculine stage has an elongate aperture with a simple tooth like typical *Quinqueloculina,* the later triloculine stage a bifid tooth like typical *Triloculina,* and the adult develops the typical broad aperture and complex tooth of the genus *Biloculina.*

BILOCULINA DEPRESSA d'Orbigny.

Plate 28, figs. 1, 2.

Biloculina depressa d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 298, No. 7; Modèles, No. 91.—H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 145, pl. 2, figs. 12, 16, 17; pl. 3, figs. 1, 2.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 87.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 117.

Description.—Test in front view nearly circular, compressed, toward the periphery extending out into a thin carina, median portion rotund, in end view ellipsoid, the edges angled and drawn out into the carina; wall smooth, dull white; aperture broad, without a neck, the tooth at the ventral side wide, extending nearly the whole width of the aperture and in end view nearly filling the opening, leaving the actual aperture but a narrow slit-like opening; at the opposite end of the chamber there is often a slight fold formed by the covering over of the tooth of the previous aperture.

Diameter, specimens occur which have a diameter of 1.5 mm.

Distribution.—This is much the most common species of the genus in the North Pacific material that I have examined. It is one of the species more or less characteristic of *Globigerina*-ooze. The species has been recorded at numerous North Pacific stations by Brady, Goës, Picaglia, and Bagg. These stations range in depth from 104 to 3,125 fathoms, only two of them, however, being less than 500 fathoms in depth.

In the *Albatross, Nero,* and *Tuscarora* material it has occurred frequently, between the Hawaiian Islands and the coast of the United

States, westward along the path of the *Nero* and along the line between Guam and Japan. These stations range in depth from 665 to 2,391 fathoms, the majority of them being about 1,500 fathoms.

BILOCULINA MURRHYNA Schwager.

Plate 28, fig. 3; plate 29, fig. 1.

Biloculina murrhyna Schwager, *Novara*-Exped., Geol. Thiel., vol. 2, 1866, p. 203, pl. 4, figs. 15 *a–c*.—Schlumberger, Mém. Soc. Zool. France, vol. 4, 1891, p. 165, pl. 9, figs. 52–54, text figs. 8, 9.

Biloculina depressa d'Orbigny, var. *murrhyana* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 146, pl. 2, figs. 10, 11.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 117.

Description.—Test in front view in young specimens nearly circular, in adult specimens somewhat longer than broad, in end view ellipsoid with the borders extended and carinate, the carina interrupted at the point opposite the aperture, leaving a sinus, rather deep and often with a long spine at each angle in young specimens; in adults sinus less deep and the spines usually reduced or wanting; aperture in the young with a neck not exceeding the periphery of the test; in adults with a prominently exserted tubular neck with a bifid tooth partially filling the nearly circular opening; wall smooth.

Diameter, usually about 1 to 1.5 mm. in adults.

Distribution.—Brady records a single North Pacific station for this species, *Challenger* 244 in 1,850 fathoms; Goës records it off the western coast of America in 1,000–1,200 fathoms; and Bagg from two *Albatross* stations off the Hawaiian Islands H4502 in 1,342 fathoms and H4555 in 1,398 fathoms. I have notes of its occurrence at about 20 *Nero* stations from the Hawaiian Islands westward to Midway Island, to Guam, and to Japan, most of the stations having depths of more than a thousand fathoms. It has occurred at *Albatross* D2806 in 1,379 fathoms off the Galapagos Islands and D4957 in 437 fathoms off Japan, as well as at a few scattered stations dredged by the *Tuscarora.*

BILOCULINA SERRATA L. W. Bailey.

Plate 29, fig. 2.

Biloculina serrata L. W. Bailey, Boston Journ. Nat. Hist., vol. 7, 1862, p. 350, pl. 8, fig. E.—Schlumberger, Feuille Jeun. Nat., vol. 13, 1883, p. 106, pl. 3, fig. 3; Mem. Soc. Zool. France, vol. 4, 1891, p. 163, pl. 9, figs. 50, 51, text figs. 6, 7.

Biloculina depressa d'Orbigny, var. *serrata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 146, pl. 2, fig. 3.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 87.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 294, pl. 40, fig. 2.

Description.—Test in front view nearly circular, central portion tumid, toward the periphery compressed, forming a carina which is deeply serrate, the middle of the margin opposite the aperture with a deep reentrant, serrations less deep toward the apertural end; wall smooth, white, somewhat shining; aperture subcircular, with a narrow neck, although not produced, tooth strongly bifid, only partially filling the opening.

Diameter, up to 2 mm.

Distribution.—Goës recorded this species from *Albatross* material from the west coast of America in 1,000 to 1,200 fathoms. Flint also recorded it from *Albatross* D2805 in 51 fathoms in Panama Bay. I have had well-developed material from but two North Pacific stations, *Tuscarora* 47, latitude 26° 41′ N.; longitude 142° 42′ E. in 1,331 fathoms, and *Albatross* D4953 in 1,350 fathoms, off Japan.

This species is evidently rare in the North Pacific. It is closely allied to *B. murrhyna*, with the deep reëntrant at the basal end and in the narrow neck and nearly circular aperture.

The original description of L. W. Bailey has evidently been overlooked, as the paper was largely devoted to diatoms. An examination of the figure and description, however, are perfectly convincing evidence that this is the same species as the one that Bailey had.

An examination of the original notes and drawings of J. W. Bailey shows that he had recognized but not published this species at a much earlier date.

BILOCULINA SARSII Schlumberger.

Plate 30, fig. 2.

Biloculina ringens H. B. Brady (not *B. ringens* Lamarck), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 142, pl. 2, fig. 7.

Biloculina sarsi Schlumberger, Mém. Soc. Zool. France, vol. 4, 1881, p. 166, pl. 9, figs. 55–59, text figs. 10–11.

Description.—Test in front view nearly circular, the ends slightly truncate, in end view ellipsoid, the periphery angled, somewhat produced, margin subcarinate; wall smooth; aperture very broad in end view, with the tooth curved, concave in the middle, the ends extended and the aperture curving in a circle about them, aperture nearly two-fifths the width of the whole test.

Diameter, about 1 to 1.3 mm.

Distribution.—Specimens seemingly identical with this species were obtained from three *Nero* stations 1254 in 264 fathoms, between Guam and Japan, and 2037 and 2070 in 55 and 285 fathoms, respectively, both off the Hawaiian Islands. It occurred at *Tuscarora* station 47, in 1,499 fathoms, latitude 24° 20′ N., longitude 54° 06′ E., and from *Albatross* H4882 in 248 fathoms in Colnett Strait, D4807 in 44 fathoms, D4874 in 66 fathoms, and D4922 in 60 fathoms, all off Japan.

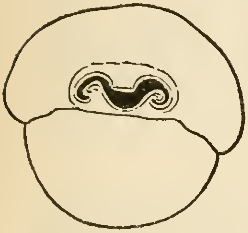
BILOCULINA VESPERTILIO Schlumberger.

Plate 30, fig. 1.

Biloculina ringens H. B. Brady (not Lamarck), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 142, pl. 2, fig. 8.

Biloculina vespertilio Schlumberger, Mém. Soc. Zool. France, vol. 4, 1891, p. 174, pl. 10, figs. 74–76, text figs. 20–22.

Description.—Test in front view subcircular, the apertural end broadly truncate, in end view very tumid; the periphery rounded, wall smooth except for small transverse ridges on the adult chambers; suture slightly indentate along the edges; aperture elongate, with a large tooth, the center with a slight point, the ends broadly rounded, the apertural opening narrow, curving about it.



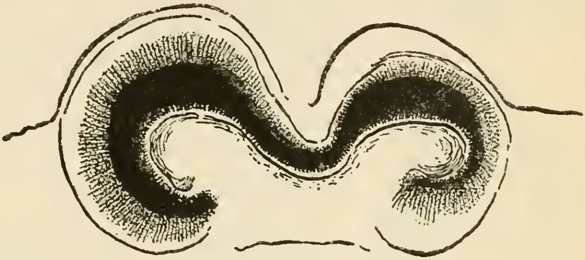


Fig. 37.—Biloculina vespertilio Schlumberger. ×5. Outline figure of very large specimen from "Albatross" D5056 in Suruga Gulf, Japan.

Fig. 38.—Biloculina vespertilio Schlumberger. ×50. Apertural portion of test in smaller specimen with the more typical sinous form of aperture and tooth with large lateral wings. From D5056.

Diameter, nearly 2 mm.

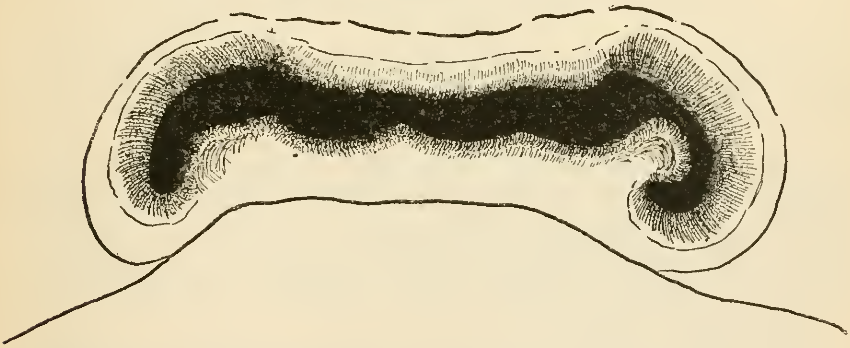


Fig. 39.—Biloculina vespertilio Schlumberger. ×50. Apertural portion of test in very large specimen where aperture has become straighter and the tooth less conspicuous. From D5056.

Distribution.—Specimens which were very similar to those described and figured by Schlumberger and by Brady were found in some numbers at *Albatross* station D5056 in 258 fathoms off the coast of Japan.

The apertural characters are very striking, having a rather beautiful series of curves.

BILOCULINA ELONGATA d'Orbigny.

Plate 31, fig. 1.

Biloculina elongata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 298, No. 4.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 144, pl. 2, fig. 9.—Schlumberger, Mém. Soc. Zool. France, vol. 4, 1891, p. 184, pl. 11, figs. 87, 88, pl. 12, fig. 89, text figs. 35, 36.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 118.

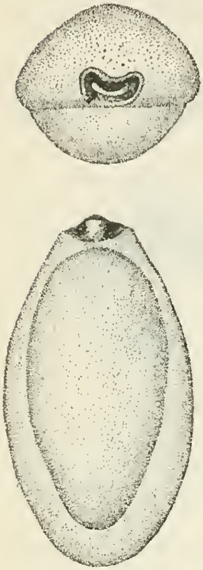


Fig. 40.—Biloculina elongata d'Orbigny. ×18.

Description.—Test elongate, pyriform, tapering gradually to the apertural end, somewhat rounded truncate at the opposite end, in end view chambers well rounded, periphery rounded, suture depressed; wall smooth, white; aperture elliptical, about twice as long as high, with a small flattened rounded tooth only about one-fourth filling the opening in end view.

Length, 0.5 to 0.8 mm.

Distribution.—Bagg records this species from the following three *Albatross* stations in the vicinity of the Hawaiian Islands: D4017 in 305 fathoms, D4025 in 275–368 fathoms, and H4567 in 1,307 fathoms. I have had material from three *Nero* stations in the same region, 2037 in 55 fathoms, 2070 in 285 fathoms, and 2071 in 271 fathoms; also from *Tuscarora* station 1 in latitude 21° 10′ N.; longitude 158° 04′ W., in 206 fathoms.

BILOCULINA GLOBULUS Bornemann.

Plate 31, fig. 2.

Biloculina globulus Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 349, pl. 19, fig. 3.—Schlumberger, Mém. Soc. Zool. France, vol. 4, 1891, p. 188, pl. 12, figs. 97–100, text figs. 42–44.

Description.—Test in front view oval, in end view irregularly globular, chambers very tumid, suture slightly depressed, in side view the last formed chamber at the aboral end somewhat curving out over the preceding chamber; wall smooth, white; aperture semicircular, with a simple flat tooth filling a large part of the opening.

Length, about 1 mm.

Distribution.—About the Hawaiian Islands the species has occurred at *Nero* stations 2037 in 55 fathoms, 2071 in 271 fathoms, and *Albatross* H3007 in 323 fathoms; near Guam, *Nero* 1464 in 891 fathoms; in Colnett Strait, *Albatross* H4882 in 248 fathoms. It also occurred at two *Tuscarora* stations 1, latitude 21° 10′ N.; longitude 158° 04′ W., in 206 fathoms, and 2 in latitude 33° 46′ N.; longitude 140° 21′ E., in 437 fathoms.

BILOCULINA ANOMALA Schlumberger.

Plate 32, fig. 1.

Biloculina anomala Schlumberger, Mém. Soc. Zool. France, vol. 4, 1891, p. 182, pl. 11, figs. 84–86; pl. 12, fig. 101, text figs. 32–34.

Description.—Test pyriform in front view, broadest near the aboral end, tapering toward the apertural end, the chambers in end view well rounded; the suture depressed, periphery of the test broadly rounded; wall smooth, white; aperture arcuate, fairly broad, in front view the dorsal edge of the aperture making an obtuse angle, which in end view shows as a slight projection into the curved line of the aperture; tooth elongate with curved ends.

Length, about 1 mm.

Distribution.—I have haa this species from but two North Pacific stations, *Albatross* H2923 in 392 fathoms and *Nero* 2070 in 285 fathoms, both in the vicinity of the Hawaiian Islands. These specimens had all the external characters of the species. Especially distinct was the angle mentioned by Schlumberger as a characteristic feature of the species. Material was not in sufficient quantity, however, to section.

BILOCULINA LUCERNULA Schwager.

Plate 32, fig. 2.

Biloculina lucernula Schwager, *Novara*-Exped., Geol. Theil., vol. 2, 1866, p. 202, pl. 4, figs. 14*a–c*, 17 *a*, *b*.—Schlumberger, Mém. Soc. Zool. France, vol. 4, 1891, p. 185, pl. 12, figs. 90–96, text figs. 37–41.

Biloculina bulloides H. B. Brady (not d'Orbigny) Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 142, pl. 2, figs. 5, 6.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 117.

Biloculina tubulosa H. B. Brady (not Costa), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 147, pl. 3, figs. 6, 14.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 86.—Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 293, pl. 34, fig. 1.

Description.—Test of adult in front view nearly circular, the apertural and aboral ends projecting somewhat; in end view the chambers well curved; the periphery bluntly angled, wall slightly roughened by the fine layer of sand which seems to be characteristic of the species, often giving it a yellowish brown appearance; aperture exserted, with a short cylindrical neck, truncate at the end, in end view circular, the small tooth well rounded, about half filling the opening.

Length, up to 1.5 mm.

Distribution.—Goës has recorded this species from *Albatross* D3375, in 772 fathoms off the western coast of America under the name *B. tubulosa*, and Flint from D3080 in 93 fathoms off the coast of Oregon. Bagg records it as *B. bulloides* from four *Albatross* stations off the Hawaiian Islands, D4000 in 104–213 fathoms, D4025 in 275–368 fathoms, H4555 in 1,398 fathoms, and H4596 in 367 fathoms.

The only well-characterized adult material I have had is from *Nero* station 1012 in 1,932 fathoms, between Guam and Japan, and *Nero* 1466 in 234 fathoms off Guam.

In many of the specimens of this species as shown by Schlumberger, the adult does not reach the complete biloculine development, but still retains a modified triloculine condition even in its last whorl. Such conditions are seen in many of the specimens recorded as *B. tubulosa.* The fine sand layer incorporated into the outer wall is a very striking characteristic of the species.

BILOCULINA DENTICULATA (H. B. Brady).

Plate 33, fig. 1.

Biloculina ringens (Lamarck), var. *denticulata* H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 143, pl. 3, figs. 4, 5.

Description.—Test roughly quadrangular in front view; in end view compressed, biconvex; apertural end broadly rounded; opposite end with a series of short irregular teeth; wall smooth; aperture very boad and narrow, extending nearly the whole width of the test, the ends somewhat expanded, tooth long and narrow, making the inner border of the aperture plate-like, somewhat raised above the level of the surface to which it is attached, as is the whole border of the aperture.

Length, up to 0.90 mm.

Distribution.—The typical material of this variety came from Honolulu coral reefs, Hawaiian Islands, in 40 fathoms; off Tongatabu, Friendly Islands, in 18 fathoms, and off the Admiralty Islands, in 15 to 20 fathoms. Millett records it from the Malay region. It seems, therefore, in its typical form to be an East Indian species and its relation to the Eocene *B. ringens* only remote.

The best material I have had is from shallow water in Apra Bay, Guam.

BILOCULINA DENTICULATA (H. B. Brady), var. STRIOLATA (H. B. Brady).

Plate 33, figs. 2, 3.

Biloculina ringens (Lamarck), var. *striolata* H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 143, pl. 3, figs. 7, 8.—Millett, Journ. Roy. Micr. Soc., 1898, p. 262, pl. 5, fig. 8.

Description.—General form similar to the typical *B. denticulata,* but with the added character of a definite surface ornamentation consisting of a series of costae on the lower half of the penultimate chamber, occasionally on the ultimate also.

Length, up to 0.85 mm.

Distribution.—Brady described this variety from a few stations among the islands off the southern shores of New Guinea, just west of Torres Straits, in 6 to 8 fathoms. Millett records it at one station in the Malay region, Barvean Roads, between Java and Borneo, in 14 fathoms. The only material I have had that figured here is from *Nero* station 2071, in 271 fathoms, off the Hawaiian Islands.

This record links closely the distribution of this variety with the typical form of the species.

BILOCULINA COMATA H. B. Brady.

Plate 34, fig. 1.

Biloculina comata H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 45; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 144, pl. 3, figs. 9*a*, *b*.

Description.—Test subglobular, the chambers very much inflated and rotund, in end view subcircular, wall ornamented with numerous fine longitudinal costae; aperture elongate, with a tooth with large wing-like developments at the ends.

Length, up to 2.5 mm.

Distribution.—From most of the records for this species it seems to be widely distributed at medium depths. In the North Pacific material I have examined it has occurred at the following stations: about the Hawaiian Islands, *Albatross* station H2922, in 268 fathoms; H3007 in 323 fathoms; *Nero* 200 in 625 fathoms; 366 in 1,511 fathoms and 1692 in 754 fathoms between Midway Island and Guam; 1410 in 1,444 fathoms between Guam and Japan.

BILOCULINA COMATA H. B. Brady, var. SERRATULA, new variety.

Plate 34, figs. 2, 3.

Description.—Test in general similar to *B. comata,* the ornamentation much closer and finer and less evenly distributed, the test being a striated one rather than a test with costae as in the typical form; the periphery with a few very prominent tooth-like projections; apertural end contracted into a short neck; aperture itself nearly circular with a small bifid tooth.

Length, up to 2 mm.

Distribution.—Type-specimen (Cat. No. 9164, U.S.N.M.) from *Nero* station 1299 in 1,817 fathoms; others from *Nero* station 1294 in 1,417 fathoms and 1311 in 1,503 fathoms, all between Japan and Guam.

Added data may show that this is a definite species rather than a variety of *B. comata,* as it has a considerable number of distinctive characters. More material, however, is desirable.

BILOCULINA MILLETTII, new species.

Plate 34, figs. 4, 5.

Miliolina durrandii Millett (part) Journ. Roy. Micr. Soc., 1898, p. 268, pl. 6, figs. 8–10 (not fig. 7).

Description.—Test in front view broadly elliptical, in end view compressed, chambers biconvex, the periphery with a definitively developed thin carina, wall smooth except for occasional transverse ribs usually indistinct; aperture slightly produced, broadly elliptical, with a slightly thickened border joining the carina at its outer edge; the aperture with a small bifid tooth.

Length, up to 1 mm.

Distribution.—Millett's material was from the Malay region. The specimens here figured (type Cat. No. 9165, U.S.N.M.) are from Hongkong Harbor.

In his figures Millett apparently has two distinct species, one a *Quinqueloculina* or *Massalina* with a conspicuous surface ornamentation of oblique costae near the peripheral border of the apertural end of the chambers, the other a smooth *Biloculina*. All the figures are of equal or greater magnification than figure 7, so that is apparently not the young of the form shown in the other figures, 8 to 70.

BILOCULINA SEMICOSTATA, new species.

Plate 34, fig. 6.

Description.—Test in front view subcircular, in end view somewhat compressed, biconvex; wall smooth except for the definite costae of the ornamentation running from the aperture as a single median longitudinal costa, soon becoming dichotomously divided into two, which run slightly beyond the median point of the test, where they gradually disappear; penultimate chamber with similar costae; apertural end somewhat produced and contracted to form a subcylindrical neck with a slightly thickened lip and broadly elliptical aperture with a rounded tooth filling a large part of the aperture.

Length, about 1 mm.

Distribution.—Type-specimen (Cat. No. 9166, U.S.N.M.) from *Nero* station 372 in 1,738 fathoms between Midway Island and Guam.

The definite single median costae, becoming divided into two in the central portion of the surface of the chamber, is the most striking feature of this apparently deep-water species.

BILOCULINA FLINTII, new species.

Plate 35, fig. 1.

Description.—Test spinose, the periphery with a series of irregular spinose projections and a stout spine in the middle of the surface of each chamber; wall otherwise smooth, apertural end contracted and extended into a short conical neck with a circular aperture and a bifid tooth.

Length, up to 1.35 mm.

Distribution.—Type-specimen (Cat. No. 9167, U.S.N.M.) from a *Nero* station near Midway Island, but without number. Other specimens are from *Nero* station 461 in 711 fathoms and 1692 in 754 fathoms between Midway Island and Guam.

This is a rather striking species with its large spines and projecting neck. It is named after Dr. James M. Flint, of the United States National Museum.

Genus NEVILLINA Sidebottom, 1905.

Nevillina Sidebottom (Type *N. coronata* (Millett)), Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, pt. 2, No. 11, 1905, p. 1.

Description.—"Test free, elongate, more or less pyriform, circular in transverse section, the final chamber completely embracing the previous one. Aperture circular, complex, formed by numerous incurved lamellae, meeting centrally."

The above is the original description of the genus as given by Sidebottom. The early stages are shown in his figures to be triloculine before the final single chambered condition is taken on. Evidently this is a genus which is developed from *Biloculina* and is found in a region containing older types such as *Trigonia* and *Nautilus.* Comparing the fossil foraminifera, the relationships of this most interesting form are rather clearly indicated.

Munier-Chalmas and Schlumberger have described two genera, *Idalina* and *Periloculina,* from the Upper Cretaceous of southern Europe, which are very clearly related to this genus *Nevillina.* In both *Idalina* and *Periloculina* the same character of a completely embracing chamber is found in the adult and the aperture is also complex, in both having a large area with many openings radiating toward the center. In *Idalina* especially is found a circular aperture with numerous roughly triangular openings with the base at the periphery and apex toward the center, rather more ornate and complex than in *Nevillina,* but essentially the same.

The development of both *Idalina* and *Periloculina* has been worked out by Munier-Chalmas and Schlumberger in great detail.

In the development of *Idalina,* at least in the microspheric form, after a *Cornuspira* stage following the proloculum, there is developed the regular quinqueloculine test with a 2/5 arrangement of the chambers—that is, each succeeding chamber placed at a point 144° from the preceding one, five chambers being necessary to make up the periphery. This in turn is followed by a regular triloculine stage, in which the chambers are added 120° from one another, three chambers completing the periphery, followed in turn by a biloculine stage with chambers 180° from one another, two chambers completing the periphery. In the final adult stage the last formed chamber embraces all the others, except at the point of attachment above the previous aperture. The development of *Periloculina* shows the same series of stages in the microspheric form at least.

The very early stages in *Nevillina* are not described, but there is evidently an early triloculine stage followed by a biloculine one before the adult embracing chamber is formed. These stages are shown in Sidebottom's figures and noted by him. Microspheric specimens would undoubtedly show the complete series of developmental stages already noted for *Idalina*.

This is, then, a most interesting recent genus, allied closely with these upper cretaceous genera of southwestern Europe. It is found also in that portion of the oceans which is known to contain some of the most ancient forms in regard to certain groups of the mollusca at least.

A single species is known and it seems to be very rare.

NEVILLINA CORONATA (Millett).

Plate 35, figs. 2–5.

Biloculina coronata Millett, Journ. Roy. Micr. Soc., 1898, p. 263, pl. 6, figs. 6*a–c*.

Nevillina coronata Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, pt. 2, No. 11, 1905, p. 1, pl., figs. 1–8.

Description.—"Test elongate, more or less pyriform, circular in transverse section. Aperture circular, complex, formed by numerous incurved lamellae, meeting centrally."

Length, up to 2 mm.

Distribution.—Millett's specimen was from the northeast coast of Sumatra, while those of Sidebottom were from Port Blair, east side of Andaman Island, at entrance to the port, between Ross Island and the main island, 16 fathoms, and Sulu roadstead, 12 fathoms. The last station is followed by this note: "Very strong tide sweeping through the anchorage. Many shoals, and reefs of growing coral in the Sulu Sea, and many banks frequented by pearl fishers."

From the fact that the species does not seem to have been taken by the *Challenger* and that Millett had but a single specimen it is evident that it is a very rare species.

The description and figures are from Sidebottom.

Genus PENEROPLIS Montfort.

Nautilus (part) Forskål, Descr. Anim., 1775, p. 125.

Peneroplis Montfort, Conch. Syst., 1808, 65th genre, p. 259.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 203.

Description.—Test planospiral, at least in the early stages, whole test lenticular, thick or much compressed, circular, crosier-shaped or cylindrical; surface smooth or the chambers longitudinally striate; chambers entire, not subdivided as in the following genera; aperture in the complanate forms consisting of a linear series of pores on the apertural face, in the less compressed forms an irregularly arranged series of pores and in the more or less uncoiled forms often becoming dendritic.

There are numerous varieties or species which by recent authors have usually been placed in a single species, *P. pertusus* (Forskål). As the various forms seem to have rather constant characters of form in combination with certain characters of aperture it seems as though they may really be more distinctive than has been given general credit. The genus is especially common in shallow waters of the tropical regions, being one of the characteristic foraminifera of coral reefs.

The young of *Peneroplis pertusus* have been observed by Schacko. Copies of two of his figures are given (fig. 1). In this early development at the time that the mégalospheric young leave the parent test they consist each of a globular or oval proloculum with the encircling second chamber usually about a half coil in length, being very similar to the early stage of the Quinqueloculine series and of *Spiroloculina*. These two chambers have a thin shell wall of even thickness throughout, the wall of the second *Cornuspira*-like chamber being continuous with that of the proloculum and building no floor on the adjacent wall of the proloculum. The apertural end of the second chamber has a slightly thickened lip.

Figure 41 shows the development seen in the early chambers of the ordinary megalospheric form, the proloculum measuring 35μ in this specimen. Here, as in the young specimen (fig. 1), there is a globose proloculum (1) followed by the elongated, coiled second chamber (2) comparable to *Cornuspira*. In *Peneroplis* as in the two following genera (*Orbiculina* and *Orbitolites*) the first and second chambers are perforated by very fine pores. *Peneroplis* was removed from this group by Rhumbler on this basis of perforations, but it has since been shown by Lister to be equally characteristic of the early chambers of *Orbiculina* and *Orbitolites*.

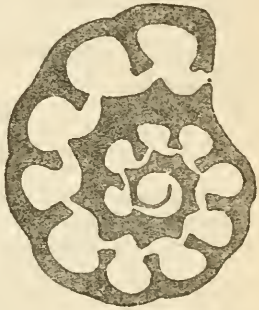


Fig. 41.—Early chambers of Peneroplis pertusus, var. arietinus, ×83. Megalospheric proloculum 35μ in diameter.

The third chamber (3) is more or less globular, connecting with the second chamber by a narrow passage, circular in cross section. The floor of this chamber is laid down on the wall of the proloculum, causing an appreciable thickening. The aperture of chamber 3 is on the inner border of the apertural wall and takes an oblique direction as it traverses the wall of the test. This obliquity causes a thickening of the wall below, which is characteristic throughout the later development of the test. Succeeding chambers are very similar to chamber 3 in their general characters. This series of chambers forms a close coiled test. In the specimen figured the first eight globular chambers make up a complete coil. In succeeding coils the number of chambers in a single coil is larger, as the chambers do not increase in size proportionately to the increase in the size of the test.

All of the earlier chambers of *Peneroplis* have similar apertures but in later coils there are developed multiple apertures in some cases. Certain forms may complete their tests with all of the apertures single; others may have multiple apertures developed fairly early. This apparently has a definite relation to the form of the test.

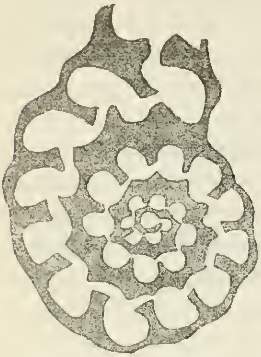


Fig. 42.—Early chambers of Peneroplis pertusus, var. arietinus, ×100. Microspheric proloculum 18μ in diameter.

The microspheric form of the test (fig. 42) differs from the megalospheric form in the size of the proloculum, the number of coils in the test, and especially in the loss of the *Cornuspira*-like second chamber. The same condition will be noted in the two following genera, *Orbiculina* and *Orbitolites*. This is a very peculiar condition in which the microspheric form is the more accelerated in this respect, while in most of the genera of the family it is the megalospheric form which is the most accelerated and therefore most apt to skip certain of the early stages.

PENEROPLIS PERTUSUS (Forskål).

Plate 36, fig. 1; plate 37, figs. 1, 2, 6.

Nautilus pertusus Forskål, Descr. Anim., 1775, p. 125, No. 65.

Peneroplis pertusus Jones, Parker, and H. B. Brady, Foram. Crag., 1865, p. 19.—H. B. Brady, Rep. Voy. *Challenger*, 1884, p. 204, pl. 13, figs. 16, 17.

Description.—Test planospiral, composed of several coils, central umbilical portion usually visible throughout the development of the test, chambers numerous, increasing gradually in height, but the test close coiled throughout; sutures somewhat depressed, wall marked by longitudinal, slightly oblique lines; aperture consisting of numerous slightly elongate pores along the apertural face, the whole with a thickened lip.

Diameter, up to 2 mm.

Distribution.—Bagg records this typical form from *Albatross* station 4017 in 305 fathoms near the Hawaiian Islands and Rhumbler from shore sands of Laysan Island. In the *Nero* material the typical form has occurred at numerous stations off the Hawaiian Islands in from 22 to 271 fathoms, off Guam, *Nero* 1466 in 234 fathoms, from Manila Bay and from Gaspar Straits, North Pacific Exploring Expedition, Captain Rodgers. It also occurred at *Tuscarora* 60, latitude 21° 14′ N.; longitude 157° 36′ W. in 63 fathoms.

Besides this typical, planospiral, closely coiled form, there are several different forms which seem worthy of at least varietal distinction. In the material at my disposal these do not seem to have their distinctive characters broken down as claimed by Brady, but seem to be well characterized. In their earlier stages they may not be easily distinguished, but this is also true of various allied forms in many groups.

PENEROPLIS PERTUSUS (Forskål), var. PLANATUS (Fichtel and Moll).

Plate 37, fig. 3.

Nautilus (*Lituus*) *arietinus* (part) Batsch, Conch. Seesandes, 1791, p. 4, pl. 6, figs. 15*a*, *b*.

Nautilus planatus, var. B. Fichtel and Moll, Test. Micr., 1803, p. 91, pl. 16, figs. 1*d*, *e*, *f*.

Peneroplis planatus d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 285, No. 1; Modèles, No. 16.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 204, pl. 13, fig. 15.

Description.—Test in the young close coiled, becoming in the adult broad and complanate, the chambers increasing rapidly in height, wall ornamented with numerous longitudinal costae, broken at the depressed sutures; aperture consisting of a long, single row of small circular pores along the median line of the flattened apertural face.

Distribution.—Bagg records this variety from *Albatross* station 4694 in 865 fathoms off the Hawaiian Islands. I have specimens from a single *Nero* station in the same region 2039 in 24 fathoms. It also occurred in the material from Gaspar Straits, from Hongkong, and from the *Tuscarora* from Manila Bay.

In some respects the young of this variety may resemble the typical form, but the height of the chambers increases fairly early and it is much flatter as well. The apertural characters of the adult are also seen fairly early in the development.

PENEROPLIS PERTUSUS (Forskål), var. CARINATUS d'Orbigny.

Plate 37, fig. 4.

Peneroplis carinatus d'Orbigny, Foram Amér. Mérid., 1839, p. 33, pl. 3, figs. 7, 8.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 205, pl. 13, fig. 14.

Description.—Test planospiral, nautiloid, each coil completely covering the preceding to the umbilicus, test close coiled throughout, sutures usually strongly limbate; wall smooth; aperture consisting of numerous small circular pores scattered over the roughly triangular apertural face.

Distribution.—Specimens of this variety were found in some numbers in the material from Gaspar Straits but were not found elsewhere in the North Pacific material.

This form seems very different from most of the others and seems more worthy of specific rank than the others included here.

PENEROPLIS PERTUSUS (Forskål), var. ARIETINUS (Batsch).

Plate 36, fig. 2; plate 37, fig. 5.

Nautilus (*Lituus*) *arietinus* (part) BATSCH, Conch. Seesandes, 1791, p. 4, pl. 6, fig. 15*c*.

Peneroplis arietinus PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 26, pl. 1, fig. 18.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 204, pl. 13, figs. 18, 19, 22.

Description.—Test planospiral in its early stages, later becoming uncoiled and building chambers in a linear series, in transverse section elongate elliptical, wall longitudinally striate, aperture consisting of an irregular series of pores in the middle line of the apertural face.

Distribution.—Rhumbler has recorded this variety from shore sands of Laysan Island. I have it from *Nero* stations 2039 in 24 fathoms and 2042 in 55 fathoms off the Hawaiian Islands, from Gaspar Straits, and *Tuscarora* material from Manila Bay.

Genus ORBICULINA Lamarck, 1816.

Nautilus (part) FICHTEL and MOLL (type, *O. adunca* (Fichtel and Moll)), Test. Micr., 1803, p. 112.

Orbiculina LAMARCK, Ency. Méthod., pt. 23, 1816, p. 468.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 208.

Description.—Test planospiral, at least in its early stages, the chambers numerous, and in the later stages, at least, subdivided into chamberlets, the early chambers in all forms extending over the early test to the umbilical region, making a completely involute test in the early stages, later tests may continue the completely involute character, or may become annuli or build a crosier-shaped test, wall usually pitted, sometimes smooth; aperture in the adult usually consisting of a double row of small circular openings usually opposite, along the median portion of the apertural face of the test.

This genus may most easily be distinguished from *Peneroplis* by its subdivided chambers and from *Orbitolites* by the early chambers which in *Orbiculina* are involute, causing a thickening of the test in the umbilical region. From *Orbitolites duplex* it may be distinguished by the pores which in circular specimens of *Orbiculina* are near the median line of the apertural face and usually opposite, while in *Orbitolites duplex* they are near the peripheral margins and usually alternate.

Orbiculina is not at all common in the North Pacific, but from the records appears to be common about the East Indies and Philippines. A comparison of the development of the two most distinctive forms *O. compressa* and *O. adunca* is here given for a comparison on one hand with *Peneroplis* and on the other with *Orbitolites*.

Development of Orbiculina compressa d'Orbigny.

The early chambers in a specimen of this species are shown in figure 43. There is an oval proloculum with a thin wall of uniform thickness. The second chamber is elongate, closely coiling on the surface of the proloculum for about a half coil in length. Both the proloculum and this second chamber are finely perforate, a character seen also, as already noted, in the young of *Peneroplis.* The third chamber is globular and connects with chamber 2 by a single aperture. Chambers 3 to 7 are of the same general character, and at this stage (in section at least) this might be the young of *Peneroplis.* Chamber 7 completes a single coil from the proloculum. This number of chambers is also very similar to the condition seen in the first coil of *Peneroplis.* Chamber 8 adds a new character, that of multiple apertures, there being two in this chamber. Chambers 8 to 12 each have two apertures. Chamber 15 has developed three apertures.

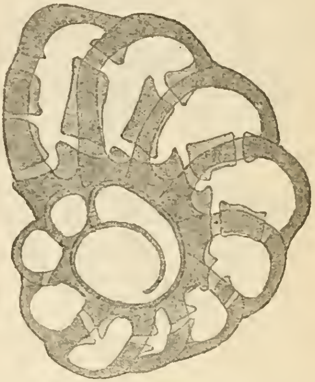


FIG. 43.—EARLY CHAMBERS OF ORBICULINA COMPRESSA D'ORBIGNY, × 83.

As the chambers increase in height there is a corresponding increase in the number of the apertures. In the later development of this same specimen (fig. 44) the chambers increase rapidly in height from the sixteenth to the twentieth. The outer end of each chamber keeps to the outer curve of the test which has taken on a less closely coiled condition. As the opposite or inner end of each chamber extends back to the previous coil, a considerable increase in the extent of the chamber must necessarily result. Chamber 21 initiates a new character, its outer end extending beyond that of the preceding and back on the outer curve of the test. This is continued by the following chambers each extending back at both ends to the wall of the earlier built portion. This method of growth is continued until the opposite ends of a chamber meet on the peripheral wall and make a complete annulus. This takes place in this individual at the thirty-fifth chamber. From this point each chamber forms a complete annulus about the preceding chambers throughout succeeding growth.

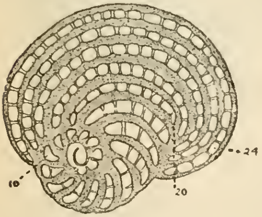


FIG. 44.—DEVELOPMENT OF A SPECIMEN OF ORBICULINA COMPRESSA D'ORBIGNY, UP TO AND INCLUDING THE TWENTY-FOURTH CHAMBER. ×25.

Development of Orbiculina adunca (Fichtel and Moll).

This species in its early development is in most respects comparable to that of the preceding species, *O. compressa,* but is much more accelerated. There is in the megalospheric form (fig. 45), a large, nearly spherical proloculum, followed by an elongated chamber of a half coil in length. This second chamber is very low at its inception but widens gradually toward its apertural end. The wall of the proloculum and second chamber is continuous, of uniform thickness, in the second chamber building no floor, and as already noted in *Peneroplis* and *O. compressa* the wall is perforate. Chamber 3 is globular with a single aperture exactly comparable to the third chamber of *O. compressa* and also to the third chamber of *Peneroplis*. Its shell development may be seen in the figure, continuing the periphery of the test from chamber 2 and making a thin layer on the apertural wall of that chamber, building its floor directly on the wall of the proloculum. This same development may be seen in the chambers of *O. compressa* (fig. 43).

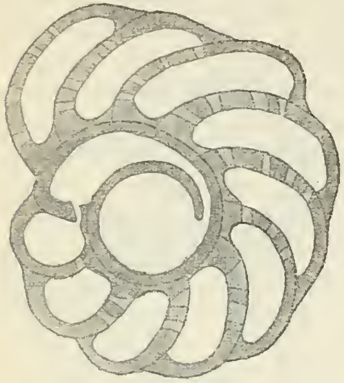


Fig. 45.—Early chambers of Orbiculina adunca, by transmitted light, × 50.

In *O. adunca* chamber 4 has two apertures, thus taking on here the character which was taken on in the specimen of *O. compressa* in the eighth chamber and in *Peneroplis* taken on much later than this, the sixteenth chamber in Schaçko's figure and in some specimens of *Peneroplis* never reached (fig. 41). *O. adunca* is then a much accelerated species.

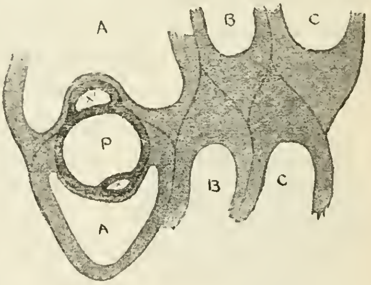


Fig. 46.—Portion of vertical section of Orbiculina adunca, × 50, showing early stages and later involute whorls in section on right BB', CC'. P, proloculum, XX', second cornuspira-like chamber cut on both sides of the proloculum, A, A', chambers of first volution.

Chamber 5 has also two apertures. Chamber 6 has three apertures, a character not attained in the specimen of *O. compressa* until chamber 13. Chamber 7 also has three apertures. Chamber 8 has four apertures, as have the other chambers shown in the figure. Instead of the test being a compressed one as in *O. compressa*, *O. adunca* has a much thicker test due to the overlapping of the preceding chambers at the sides. This is shown in the section (fig. 46) at right angles to the first section. In this figure P shows the proloculum and X and X′ the two opposite portions of chamber 2 in cross section. At X the common wall between the two chambers is bent inward and at

X′ it is simply flattened. This is interesting in comparison with the section of the actual two-chambered young of *Peneroplis* figured by Schako (fig. 1). where the wall of the proloculum is simply flattened on the two sides and not bent inward. Lister's figure of a similar section of *O. adunca* shows this concavity at one side and flattening at the other as in our figure. At A is shown the section across a chamber in the position of chamber 8 or 9 in the other section (fig. 45)—that is, a chamber at the point where one complete coil has been made. At A′ is shown a portion of a chamber on the opposite side. These two chambers indicate in section the width of the test at the second coil. Chambers B and B′ show the thickness of the test at the end of the third coil and C and C′ at the completion of the fourth coil. Each coil slightly overlaps its preceding half, as is seen in the cross section. After making about four complete coils the chambers increase greatly in height in this form. This may continue until the wing-like growth thus formed swings completely about the test, but in this species the ends of a chamber do not unite with one another to form annuli, but the growth turns back onto the earlier portion of the test and at this edge the test becomes formed of two nearly parallel plates.

O. compressa typically forms but one and a half coils before beginning to extend back on its own periphery and very soon thereafter the opposite ends of a chamber unite and form a complete annulus. The annuli are formed throughout further growth and the size of the test increases rapidly.

The two types of development in later stages are very different, that of *O. compressa,* the simpler, more nearly like *Peneroplis* and leading directly toward *Orbitolites,* especially the simplest species *O. marginalis* which it resembles in many respects. The later development of *O. adunca,* however, is more complex and tends in certain respects toward the genus *Alveolina.*

ORBICULINA ADUNCA (Fichtel and Moll).

Plate 37, figs. 7, 8.

Nautilus aduncus Fichtel and Moll, Test. Micr., 1803, p. 115, pl. 23.

Orbiculina adunca Lamarck, Tabl. Encycl. et Meth., 1816, pl. 468, figs. 2*a–c*.—d'Orbigny, in De la Saga, Hist. Fis. Pol. Nat. Cuba (Foraminifères) 1839, p. 81, pl. 8, figs. 8–14.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 209, pl. 14, figs. 1–13.

Description.—Test typically planospiral, involute, each coil completely covering the previous one; chambers increasing rapidly in height, much curved; sutures distinct, but slightly depressed; wall smooth or slightly pitted; aperture consisting of usually a double series of small rounded pores, each with a slight raised border, on the apertural face of the test, which is flattened or slightly depressed.

Distribution.—Brady records this species from the North Pacific only from among the Philippines. The only material I have from this region is collected by the *Tuscarora* in Honduras Bay.

Brady records the species from about various East Indian Islands, and it is interesting to note that in the *Challenger* material it is not given from the Honolulu Reefs. Bagg records it from two *Albatross* stations but an examination of his material from both these stations shows that the specimens are *Orbitolites marginalis* and not *Orbiculina.* They resemble the flattened compressed *Orbiculina compressa*, but the central portion is not involute, the early chambers being all visible as in typical *Orbitolites marginalis.* I have failed to find *Orbiculina* in the Hawaiian region, although I have had but a small amount of shallow water material.

Genus ORBITOLITES Lamark, 1801.

Orbitolites Lamarck, Syst. Anim. sans Vert., 1801, p. 376 (Type *O. complanata* Lamarck).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 210.

Description.—Test typically discoidal, the early chambers, in the microspheric form at least, following the proloculum and *Cornuspira*-like second chamber, arranged in a gradually widening spiral, followed by chambers extending in length and becoming annuli; chambers divided into chamberlets, each with one or more apertures on the rim of the test.

A rather full description is given of the development as the species are discussed and it need not be considered here.

ORBITOLITES MARGINALIS (Lamarck).

Plate 38, figs. 1, 2.

Orbulites marginalis Lamarck, Hist. Nat. Anim. sans Vert., vol. 2, 1816, p. 196, No. 1.

Orbiculina (*Orbitolites*) *complanata* Williamson, Trans. Micr. Soc. London, ser. 1, vol. 3, 1851, p. 115, pl. 17, fig. 8; pl. 18, figs. 9, 10.

Orbitolites marginalis Carpenter, Philos. Trans., 1856, p. 192, pl. 9, figs. 1–4, etc.; Rep. Voy. *Challenger*, Zoology, pt. 21, 1883, p. 20, pl. 3, figs. 1–7; pl. 4, figs. 1–5.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 214, pl. 15, figs. 1–5.

Description.—Test circular or nearly so, flattened, chambers numerous, in a single layer, in the adult becoming annular, completely surrounding the periphery of the test; wall smooth, the area about each chamberlet slightly depressed, the center of the chamberlet slightly protuberant; apertures in a single row along the periphery of the test; the chamberlet communicating with one another by lateral openings just behind the periphery, these in turn opening backward into the preceding annular chamber.

Diameter, up to 5 mm., but usually smaller.

Distribution.—Bagg records this species as not very common at three *Albatross* stations near the Hawaiian Islands, D4000, in 104 to 212 fathoms; H4476, in 438 fathoms; and H4694, in 865 fathoms. I have had the species from the same region from the following stations: *Nero*, 2037, in 55 fathoms; 2038, in 34 fathoms; 2042, in 55 fathoms; 2043, in 58 fathoms; and 2071, in 271 fathoms; from *Nero* station 1466, in 234 fathoms off Guam, from *Alert* station 1177, in 23 to 118 fathoms, and from Gasper Straits, North Pacific Exploring Expedition, Captain Rodgers.

Orbitolites marginalis is a species which builds all its chambers, with slight exceptions, in a single plane. As a result a test is formed which when mounted in balsam may be viewed in optical section throughout. Its development is much less accelerated than that of the other species of *Orbitolites* and its study throws light on obscure points in the development of the higher, more complex species.

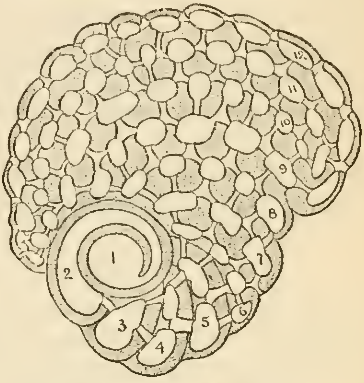


Fig. 47.—Early stages of Orbitolites marginalis, × 50, in optical section.

In figure 47 is shown the young of a megalospheric specimen of *O. marginalis*. There is a nearly spherical megalospheric proloculum (1) followed by an encircling *Cornuspira*-like chamber (2) making nearly a single coil. This differs from both *Peneroplis* and *Orbiculina*, which each had a second chamber but half a coil in length. This elongated second chamber is also seen in the other species of *Orbitolites* in the megalospheric form, sometimes being quite a full coil in length. The second chamber is very low at its inception, but gradually increases in height to its apertural end. The wall is continuous with that of the proloculum, of uniform thickness with it and builds no floor on the wall of the proloculum.

Chamber 3 is somewhat ovoid, not the globular form of the third chamber seen in *Peneroplis* and *Orbiculina*, but more like later chambers in those genera. It has two apertures instead of having a single one, as in the other genera mentioned; chamber 3 in this specimen of *O. marginalis* may be compared in this respect with the fourth chamber in *Orbiculina adunca*, with the eighth chamber in *Orbiculina compressa* or with the sixteenth chamber in the specimen of *Peneroplis*, figured by Schacko.

Chamber 4, however, becomes divided into two chamberlets by a median partition which is perforated near the apertural wall so that free communication exists between the chamberlets. The number of chamberlets increases rapidly in the succeeding chambers, as added, and the tenth chamber has nine chamberlets.

Up to and including chamber 10 the test is close coiled, although increasing rapidly in height, but with chamber 11 a new character is initiated, that of bending back on one side as was seen in chamber 21 in *Orbiculina compressa.*

Chamber 20 in this specimen of *Orbitolites marginalis* completes the circle of the periphery of the test and forms the first annulus. This corresponds with chamber 35 in *Orbiculina compressa,* where 15 chambers are necessary to complete the stage from the first bending back to the formation of the first annulus, which is in *Orbitolites marginalis* accomplished by the addition of but 10 chambers. This illustrates well the difference in the acceleration of development of these two specimens of the two different species.

ORBITOLITES DUPLEX Carpenter.

Plate 38, figs. 3, 4; plate 39, fig. 1.

Orbulites macropora (?) LAMARCK, Hist. Nat. Anim. sans Vert., vol. 2, 1816, p. 197, No. 5 (fide Carpenter).

"*Orbitolites* (duplex type)" CARPENTER, Philos. Trans., 1856, p. 120, pl. 5, fig. 10; pl. 9, fig. 10.

Orbitolites complanata, var. *macropora* PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 289.

Orbitolites duplex CARPENTER, Rep. Voy. *Challenger,* Zoology, pt. 21, 1883, p. 25, pl. 3, figs. 8–14; pl. 4, figs. 6–10; pl. 5, figs. 1–10.—H. B. BRADY, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 216, pl. 16, fig. 7, fig. 7, in text.

Description.—Test in the form of a circular disk, the surface flat or slightly concave toward the center, chambers numerous, soon becoming annular; wall smooth, chambers and chamberlets obscurely marked, apertures in the adult consisting of a double row of openings on the periphery near the margin, corresponding to the double tier of chamberlets, usually alternating.

Diameter, up to 8 mm., but usually much less.

Distribution.—Apparently the only definite North Pacific record for this species is that of Rhumbler, who records the species from Laysan Island. Near the Hawaiian Islands it has occurred at *Nero* station 2033 in 249 fathoms and 2071 in 271 fathoms. It also occurred in some numbers at *Nero* station 1466 in 234 fathoms off Guam.

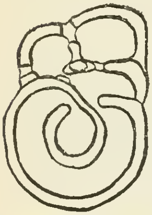


FIG. 48.—FIRST FOUR CHAMBERS OF ORBITOLITES DUPLEX, × 100.

The first four chambers of a specimen of *Orbitolites duplex* with a megalospheric proloculum are shown in figure 48. As in *O. marginalis* there is an oval proloculum followed by a long *Cornuspira*-like chamber of nearly a coil in length of equal thickness with the proloculum and building no floor. Chamber 3 is simple with two apertures as in *O. marginalis.* Chamber 4 is divided into two chamberlets.

Instead of the outer wall of these last two chambers continuing the curve of the peripheral wall of the second chamber as in *O. marginalis*, *Orbiculina*, and *Peneroplis* a tangential direction is taken on as in much later chambers in the other types. The early development in this respect then is more accelerated than in *O. marginalis*. This acceleration continues for *O. duplex* may develop an annulus in the eighth chamber instead of in the twentieth as in *O. marginalis*. In the early stages there is a single series of apertures in the peripheral wall, but in adult growth two such series are usually present.

A very interesting and significant fact of the acceleration is shown in the stage at which the megalospheric young are freed from the parent test. In *Peneroplis* as already noted the young have a proloculum and the second *Cornuspira*-like chamber only when set free. The young of *Orbitolites marginalis* I have not seen in the parent test, but in *O. duplex* the young is usually set free in the stage as shown here, many young at this stage being found in the outer chambers of the parent test and also attached nearby. This is a comparatively much later stage than in *Peneroplis* and an earlier stage than seen in the next species.

The specimens from Guam in some cases show a plate-like lateral development across the face of the test on either side. One of these specimens is figured (pl. 39, fig. 1).

ORBITOLITES COMPLANATA Lamarck.

Plate 39, fig. 2.

"Retepora *Muscipula* minima," Soldani, Testaceographia, vol. 1, pt. 3, 1795, p. 242, pl. 167, figs. *ss*, *tt;* pl. 168, fig. *xx*.

Orbitolites complanata Lamarck, Syst. Anim. sans Vert., 1801, p. 376.—Carpenter, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pt. 21, 1883, p. 29, pl. 5, figs. 14–18; pls. 6, 7, 8.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 218, pl. 16, figs. 1–6; pl. 17, figs. 1–6.

Description.—Test in the form of a circular disk, the surfaces distinctly concave toward the center, periphery usually the thickest part of the test, convex in the middle, except the first three chambers all the chambers form annuli, divided into numerous chamberlets both in the circle and laterally so that in an adult specimen there may be three tiers of chamberlets in the annular chamber, an outer series on either side of a thicker central series, those of the outer series not communicating with one another but with the central series; wall nearly smooth; apertures very numerous.

Diameter, from 1 to 25 mm., the average being well under the medium of this range.

Distribution.—Brady records this species from the Loo Choo Islands and from the Hawaiian Islands. Bagg also records it from three stations in the latter region *Albatross* D4000 in 104 to 213 fathoms, H4476 in 438 fathoms, and H4566 in 572 fathoms.

I have had material from off the Hawaiian Islands, from Hongkong Harbor in 10 fathoms, from Cagayan, Sulu Islands, Philippines, and from *Tuscarora* station 60, in latitude 21° 14′ N.; longitude 157° 36′ W. in 63 fathoms.

The species is very abundant in shallow waters of the East Indian region.

In the very large specimens with thickened edges the megalospheric young are often found in the outer chambers of the parent test. In these young four of which are figured here, there is an oval proloculum of very large size, followed by a second, *Cornuspira*-like chamber of about a quarter coil in length. This is, as usual, continuous with the wall of the proloculum and builds no floor. Instead of being evenly curved its outer end often has a tendency to swing away from a uniform curve and to suggest the tangential direction seen in much later stages of the other two species discussed, thus initiating a character of later growth as early as the second chamber. The third chamber instead of being like the third chamber of the other types of the group is nearly an annulus, its ends not quite meeting on the peripheral wall of the second chamber. This point of contact as will be seen in the four specimens here figured is very

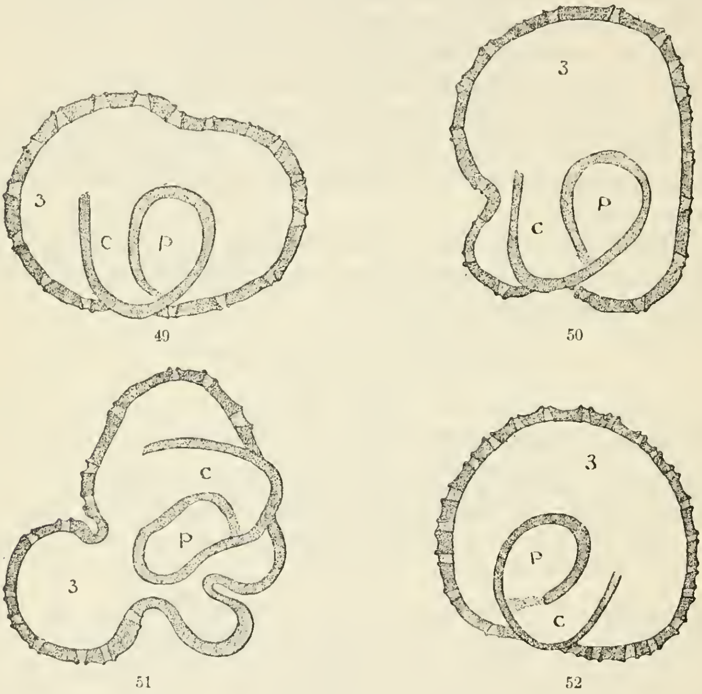


Fig. 49–52.—Young specimens of Orbitolites complanata, taken from same "mother" cell, × 36. P. proloculum, C, cornuspira-like second chamber, 3 third chamber about which the first annular chamber develops.

constant. At this stage the third chamber is often much contorted as shown in figures 49 to 51, especially marked in figure 51, where the periphery of the third chamber is greatly convoluted as though due to pressure. These young are often very crowded, and when formed the wall must be in a semi-plastic condition before it is hardened to account for the reëntrants in the wall such as show in figure 51. The outer rim of chamber 3 has numerous apertures. After the young is set free, it develops chamber 4 as a complete annulus with many chamberlets, comparable to the eighth chamber of *O. duplex* or to the twentieth chamber of *O. marginalis* showing the great acceleration that has taken place in *O. complanata*. From this point it builds annuli throughout further growth, each annulus becoming much divided and having several series of apertures on its peripheral wall.

Occasionally specimens of the megalospheric type are found with two prolocula and their accompanying later stages, but finally the two fusing and building as annulus in common, so that in later growth the synthetic test can not be distinguished from an ordinary individual with a single proloculum. This twinned condition is probably due to the closely adjacent position of the attached young when they started their annular growth. As the chambers met the protoplasm must have anastomosed and a common chamber been built. This tends to show the primitive character of the protoplasmic body.

Genus ALVEOLINA d'Orbigny, 1826.

Alveolina d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 306 (Type, *A. boscii* (Defrance)).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 221.

Description.—Test usually elliptical or fusiform, composed in the adult of elongate chambers, each running the entire length of the test, the apertural face of the last formed chamber forming the growing edge of the test; chambers divided into chamberlets with small circular apertures upon the apertural face, at least in the larger species; whole test spirally coiled about the elongate axis.

This genus seems to be confined to the shallower waters of the Tropics, being a characteristic form in dredgings from about coral reefs.

ALVEOLINA MELO (Fichtel and Moll).

Plate 39, fig. 4.

Nautilus melo Fichtel and Moll, Test. Micr., 1803, p. 118, pl. 24.

Alveolina melo D'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 306, No. 2.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 223, pl. 17, figs. 13–15.

Description.—Test subspherical or broadly elliptical, coiling on its longitudinal axis, rotaliform at least in the adult; chambers in each whorl few, about eight in number, transversely striate; apertural face forming the growing edge of the test, truncate; apertures numerous, consisting of a series of elliptical openings in a single row along the apertural face, each opening with a slight ridge about it.

Diameter, about 0.75 mm.

Distribution.—Brady records this species from off the Hawaiian Islands and this stands as the only record for the North Pacific. This is a rather isolated station as the nearest record given by Brady is Ceylon and this species does not seem to be found with the previous one in the East Indian region as it is in the West Indies.

It appears from these indications only that possibly there are more than two recent species, but without access to the material it is impossible to do more than suggest this as a possibility.

ALVEOLINA BOSCII (Defrance).

Plate 39, fig. 3.

Oryzaria boscii Defrance, Dict. Sci. Nat., vol. 16, 1820, p. 104.

Alveolina boscii d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 306, No. 5; Modèles, No. 50.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 222, pl. 17, figs. 7–12.—Chapman, Journ. Roy. Micr. Soc., 1908, pp. 151–153, pls. 1, 2, text. fig. 31.

Description.—Test elongate, fusiform, coiling on its longitudinal axis, the chambers very long, extending the whole length of the test, complex, transversely striate, apertural face forming the growing edge of the test, flattened; apertures very numerous, consisting of fine circular pores with raised borders scattered over the whole surface of the apertural face.

Length, 1.5 mm., in some regions up to nearly 1 inch.

Distribution.—The only North Pacific record for this species is that given by Brady, material taken by the *Challenger* in 40 fathoms, from the coral reefs of Honolulu, Hawaiian Islands. These specimens were small. I have had small specimens from *Tuscarora* station 60 in latitude 21° 14′ N.; longitude 157° 36′ W. in 63 fathoms, also in the vicinity of the Hawaiian Islands.

In the East Indian and Philippine regions this species grows to large size, nearly an inch in length. Both microspheric and megalospheric forms occur, the very large specimens being microspheric as shown by Chapman.

EXPLANATION OF PLATES.

Plate 1.

Fig. 1. *Cornuspira foliacea.* × 60. *a*, front view; *b*, apertural view.
2. *Cornuspira involvens.* × 40. *a*, front view; *b*, apertural view.

Plate 2.

Fig. 1. *Cornuspira foliacea.* × 20. *a*, front view; *b*, apertural view.
2. *Cornuspira involvens.* × 40. *a*, front view; *b*, apertural view.
3. *Cornuspira lacunosa.* × 30. *a*, front view; *b*, apertural view.

Plate 3.

Fig. 1. *Opthalmidium inconstans.* × 65. Irregular specimen.
2. *Opthalmidium inconstans.* × 65. A more regular specimen.
3. *Opthalmidium inconstans.* × 135. Optical section of young specimen.
4. *Opthalmidium inconstans.* × 65. Optical section of adult specimen.
5. *Opthalmidium tumidulum.* × 33 (after Brady).
6. *Spiroloculina depressa.* × 65. *a*, side view; *b*, apertural view.
7. *Spiroloculina depressa.* × 35. *a*, front view; *b*, apertural view of thicker specimen.
8, 9. *Spiroloculina depressa.* × 35. Apertures of adults.
10. *Spiroloculina depressa.* × 80. Aperture of young.

Plate 4.

Fig. 1. *Spiroloculina canaliculata.* × 25. *a*, front view; *b*, apertural view.
2. *Spiroloculina canaliculata.* × 35. Apertural view.
3. *Spiroloculina canaliculata.* × 80. Apertural view of young.
4. *Spiroloculina grateloupi.* × 25. *a*, front view; *b*, side view; *c*, apertural view.
5. *Spiroloculina grateloupi.* × 35. *a*, front view; *b*, apertural view.

Plate 5.

Fig. 1. *Spiroloculina acutimargo.* × 35.
2. *Spiroloculina tenuimargo.* × 65. *a*, front view; *b*, apertural view.
3. *Spiroloculina tenuimargo.* × 120. *a*, front view; *b*, apertural view.
4. *Spiroloculina millettii.* × 65. *a*, front view; *b*, side view; *c*, apertural view.
5. *Spiroloculina nuda.* × 65. *a*, front view; *b*, side view; *c*, apertural view.

Plate 6.

Fig. 1. *Spiroloculina costifera.* × 35. *a*, front view; *b*, apertural view; *c*, section.
2. *Spiroloculina costifera.* × 30. *a*, front view; *b*, apertural view.
3. *Spiroloculina costifera.* × 35. End view of another specimen.

Plate 7.

Fig. 1. *Spiroloculina unicostata.* × 135. *a*, front view; *b*, side view; *c*, apertural view.
2. *Spiroloculina unicostata.* × 135. *a*, front view; *b*, apertural view.
3. *Spiroloculina grata.* × 65. Front view.
4. *Spiroloculina grata.* × 75. Optical section.
5. *Spiroloculina grata*, var. *angulata.* × 30. *a*, front view; *b*, apertural view.

PLATE 8.

Fig. 1. *Nodobacularia tibia.* × 130, showing proloculum, second *Cornuspira*-like chamber and the first of the uniserial chambers (after Rhumbler).
2. *Nodobacularia tibia,* × 50, later chambers only (after Brady).
3. *Nodobacularia irregularis.* × 95 (after Rhumbler).
4. *Nubecularia bradyi.* × 50 (after Brady).
5. *Nubecularia bradyi.* × 190 (after Rhumbler).
6. *Nubecularia lucifuga.* × 255 (after Rhumbler).
7. *Quinqueloculina schauinslandi.* × 35 (after Rhumbler).
8. *Quinqueloculina schauinslandi.* × 167, by transmitted light (after Rhumbler).

PLATE 9.

Fig. 1. *Quinqueloculina agglutinans.* × 65. Hongkong. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina agglutinata.* × 33. Off Alaska. *a*, *b*, side views; *c*, apertural view.

PLATE 10.

Fig. 1. *Quinqueloculina subarenaria.* × 33. Off Hawaiian Islands. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina subarenaria.* × 33. Off Singapore. *a*, *b*, side views; *c*, apertural view.

PLATE 11.

Fig. 1. *Quinqueloculina venusta.* × 33. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina seminulum.* × 65. *a*, *b*, side views.
3. *Quinqueloculina vulgaris.* × 33. *a*, *b*, side views; *c*, apertural view.

PLATE 12.

Fig. 1. *Quinqueloculina auberiana.* × 33. *Albatross* D4874. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina cuvieriana.* × 65. Hongkong. *a*, *b*, side views; *c*, apertural view.

PLATE 13.

Fig. 1. *Quinqueloculina bicostata.* × 65. *Nero* 1158. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina bicornis.* × 65. Hongkong. *a*, *b*, side views; *c*, apertural view.

PLATE 14.

Fig. 1. *Quinqueloculina disparilis,* × 65. *Nero* 1378. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina disparilis,* var. *curta,* × 33. *Albatross* D4900. *a*, *b*, side views; *c*, apertural view.

PLATE 15.

Fig. 1. *Quinqueloculina costata,* × 65. *Nero* 2041. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina boucana,* × 65. *Nero* 2040. *a*, *b*, side views; *c*, apertural view.
3. *Quinqueloculina parkeri,* × 33. Guam. *a*, *b*, side views; *c*, apertural view.

PLATE 16.

Fig. 1. *Quinqueloculina reticulata*, × 33. Gaspar Straits.
2. *Quinqueloculina reticulata*, × 33. *Nero* 2039.
3. *Quinqueloculina reticulata*, × 65. Hongkong. *a*, front view; *b*, apertural view.

PLATE 17.

Fig. 1. *Triloculina cuneata*, × 65. (After Rhumbler.)
2. *Triloculina deplanata*, × 90. *a*, *b*, side views; *c*, apertural view. (After Rhumbler.)
3. *Quinqueloculina arenacea*, × 140. (After Rhumbler.)
4. *Quinqueloculina arenacea*, × 140. (After Rhumbler.)
5. *Quinqueloculina ferox*, × 54. (After Rhumbler.)
6. *Quinqueloculina ferox*, × 43. (After Rhumbler.)
7. *Quinqueloculina ferox*, × 57. (After Rhumbler.)
8. *Triloculina cribrostoma*, × 25. (After Rhumbler.)
9. *Adelosina laysanensis*, × 288. (After Rhumbler.)
10. *Triloculina cylindrica*, × 140. (After Rhumbler.)

PLATE 18.

Fig. 1. *Quinqueloculina dutemplei*, × 65. *a*, *b*, side views; *c*, apertural view.
2. *Quinqueloculina bradyana*, × 40. *a*, *b*, side views; *c*, apertural view.
3. *Quinqueloculina dutemplei?*, × 33. *a*, *b*, side views; *c*, apertural view.

PLATE 19.

Fig. 1. *Planispirina sphaera*, × 65. *a*, front view; *b*, side view.
2. *Quinqueloculina procera*, × 35. Horizontal section.
3. *Quinqueloculina ferussacii*, × 65. *a*, *b*, side views; *c*, apertural view.
4. *Quinqueloculina ferussacii*, × 65. End view of another specimen.

PLATE 20.

Fig. 1. *Quinqueloculina spiralis*, × 65. *a*, *b*, side views; *c*, apertural view.
2. *Massilina crenata*, × 65. *a*, front view; *b*, apertural view.
3. *Massilina annectans*, × 65. *a*, *b*, side views; *c*, apertural view.

PLATE 21.

Fig. 1. *Quinqueloculina cultrata*, × 33. *a*, side view; *b*, apertural view.
2. *Hauerina pacifica*, × 65. *a*, *b*, side views; *c*, apertural view.
3. *Triloculina suborbicularis*, × 135. *a*, *b*, side views; *c*, apertural view.

PLATE 22.

Fig. 1. *Vertebralina insignis*, × 35. (After Brady.)
2. *Vertebralina insignis*, × 35. *a*, front view; *b*, apertural view. (After Brady.)
3. *Vertebralina striata*, × 65.
4. *Vertebralina striata*, × 65. *a*, front view; *b*, apertural view.
5. *Vertebralina sulcata*, × 65. *a*, front view; *b*, apertural view.
6. *Articulina conico-articulata*, × 65. *a*, front view; *b*, apertural view.
7. *Articulina sagra*, × 35. (After Brady.)
8. *Articulina sagra*, × 35. (After Brady.)

PLATE 23.

Fig. 1. *Hauerina ornatissima*, × 65. *a*, front view; *b*, apertural view.
2. *Hauerina bradyi*, × 65. *a*, front view; *b*, apertural view.
3. *Hauerina circinata*, × 33. (After Brady.)
4. *Hauerina circinata*, × 33. (After Brady.)
5. *Hauerina ornatissima*, × 65. *a*, front view; *b*, apertural view.

PLATE 24.

Fig. 1. *Sigmoilina celata*, × 65. *a*, front view; *b*, apertural view.
2. *Sigmoilina sigmoidea*, × 65. *a*, front view; *b*, apertural view.
3. *Sigmoilina sigmoidea*, section, × 40. (After Brady.)
4. *Hauerina fragilissima*, × 65. *a*, front view; *b*, apertural view.

PLATE 25.

Fig. 1. *Triloculina tricarinata*, × 30. *a*, front view; *b*, apertural view of very large specimen.
2. *Triloculina tricarinata*, × 33. *a*, front view; *b*, apertural view.
3. *Triloculina trigonula*, × 33. *a*, front view; *b*, apertural view.
4. *Triloculina circularis*, × 65. *a*, *b*, side views; *c*, apertural view.

PLATE 26.

Fig. 1. *Triloculina circularis*, × 33. *a*, front view; *b*, apertural view.
2. *Triloculina circularis*, var. *sublineata*, × 65. *a*, *b*, side views.
3. *Triloculina oblonga*, × 33. *a*, front view; *b*, apertural view.

PLATE 27.

Fig. 1. Triloculine stage of Biloculina, × 65. *a*, front view; *b*, apertural view.
2. *Triloculina terquemiana*, × 65. *a*, front view; *b*, apertural view.
3. *Triloculina insignis*, × 65. *a*, front view; *b*, apertural view.
4. *Triloculina linnaeana*, × 33. *a*, front view; *b*, apertural view.

PLATE 28.

Fig. 1. *Biloculina depressa*, × 33. *a*, front view; *b*, side view; *c*, apertural view.
2. *Biloculina depressa*, × 33. *a*, front view; *b*, apertural view.
3. *Biloculina murrhyna*, × 33. *a*, front view; *b*, apertural view.

PLATE 29.

Fig. 1. *Biloculina murrhyna*, × 65. *a*, front view; *b*, side view; *c*, apertural view.
2. *Biloculina serrata*, × 65. *a*, front view; *b*, side view; *c*, apertural view, specimen with irregular margin.

PLATE 30.

Fig. 1. *Biloculina vespertilio*, × 20. *a*, front view; *b*, side view; *c*, apertural view of very large specimen.
2. *Biloculina sarsii*, × 33. *a*, front view; *b*, apertural view.

PLATE 31.

Fig. 1. *Biloculina elongata*, × 33. *a*, front view; *b*, side view; *c*, apertural view.
2. *Biloculina globulus*, × 65. *a*, front view; *b*, side view; *c*, apertural view.

PLATE 32.

Fig. 1. *Biloculina anomala*, × 65. *a*, front view; *b*, side view; *c*, apertural view.
2. *Biloculina lucernula*, × 65. *a*, front view; *b*, side view; *c*, apertural view.

PLATE 33.

Fig. 1. *Biloculina denticulata*, × 65. *a*, front view; *b*, side view; *c*, apertural view.
2. *Biloculina denticulata*, var. *striolata*, × 65. *a*, front view; *b*, apertural view.
3. *Biloculina denticulata*, var. *striolata*, × 33. *a*, front view; *b*, apertural view.

PLATE 34.

Fig. 1. *Biloculina comata*, × 33. *a*, front view; *b*, apertural view.
2. *Biloculina comata*, var. *serratula*, × 33.
3. *Biloculina comata*, var. *serratula*, × 33. *a*, front view; *b*, apertural view.
4. *Biloculina millettii*, × 33. *a*, front view; *b*, apertural view.
5. *Biloculina millettii*, × 33.
6. *Biloculina semicostata*, × 33. *a*, front view; *b*, side view; *c*, apertural view.

PLATE 35.

Fig. 1. *Biloculina flintii*, × 33. *a*, front view; *b*, side view; *c*, apertural view.
2. *Nevillina coronata*, × 25. Showing penultimate chamber within.
3. *Nevillina coronata*, × 25. *a*, front view; *b*, apertural view.
4. *Nevillina coronata*, × 25. Triloculine stage.
5. *Nevillina coronata*, × 25. Biloculine stage. (Figs. 2–5 after Sidebottom.)

PLATE 36.

Fig. 1. *Peneroplis pertusus*, × 33. *a*, side view; *b*, apertural view.
2. *Peneroplis pertusus*, var. *arietinus*, × 33. *a*, front view; *b*, apertural view.
3. *Peneroplis pertusus*, var. × 33. *a*, side view; *b*, apertural view.

PLATE 37.

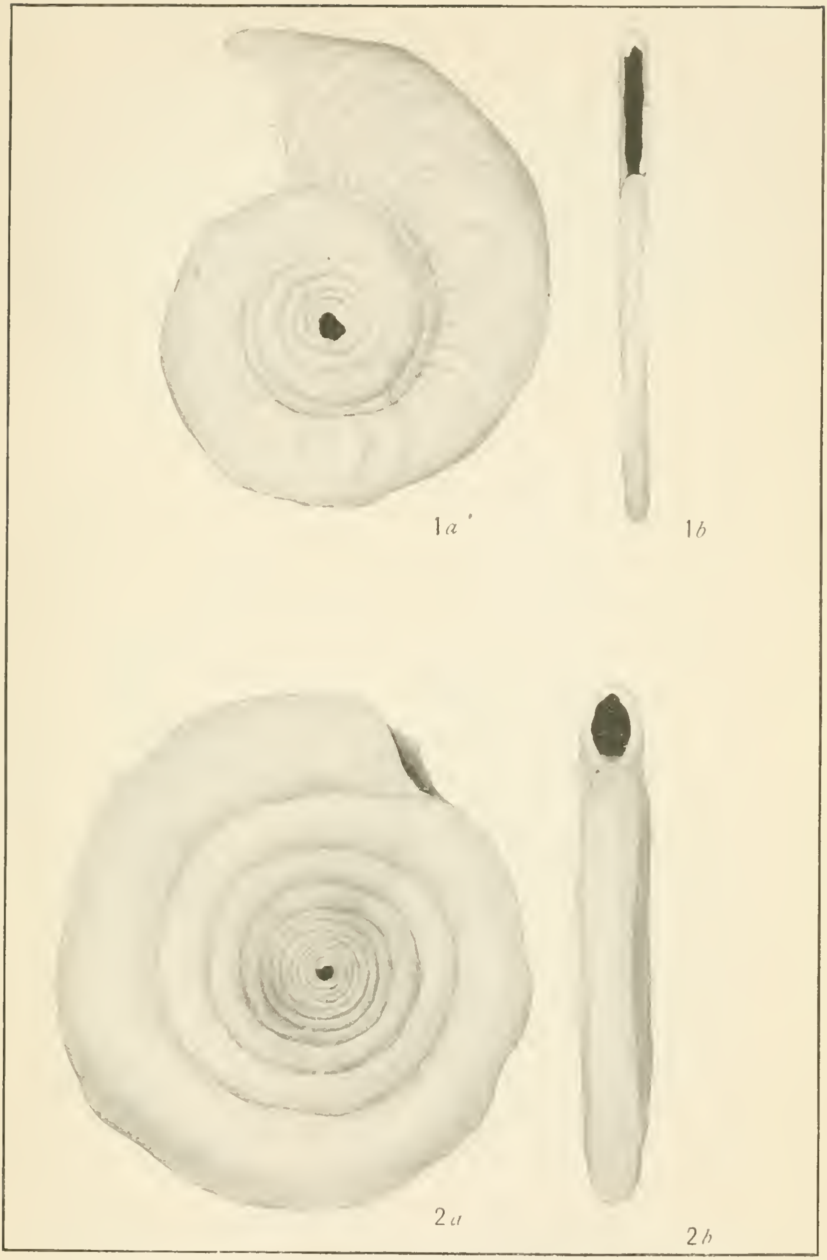
Fig. 1. *Peneroplis pertusus*, × 20. Aperture.
2. *Peneroplis pertusus*, × 20. Aperture.
3. *Peneroplis pertusus*, var. *planatus*, × 65. *a*, side view; *b*, apertural view.
4. *Peneroplis pertusus*, var. *carinatus*, × 33. *a*, side view; *b*, apertural view.
5. *Peneroplis pertusus*, var. *arietinus*, × 27. Section. (After Brady.)
6. *Peneroplis pertusus*, × 33. Aperture.
7, 8. *Orbiculina adunca*, × 20. (After Brady.)

PLATE 38.

Fig. 1. *Orbitolites marginalis*, × 30. *a*, surface view; *b*, peripheral view.
2. *Orbitolites marginalis*, × 65. Apertures.
3. *Orbitolites duplex*, × 75. Apertures.
4. *Orbitolites duplex*, × 33. *a*, surface view; *b*, peripheral view.

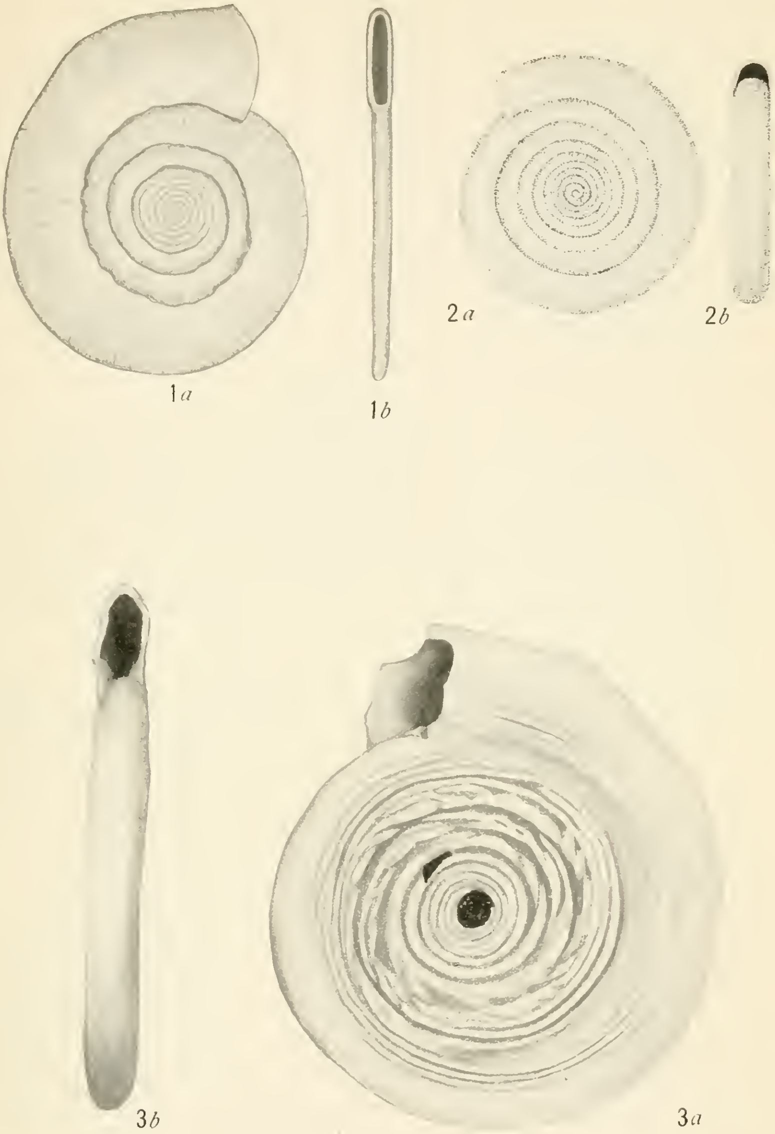
PLATE 39.

Fig. 1. *Orbitolites duplex*, × 30. Specimen with secondary growth.
2. *Orbitolites complanata*, × 30. *a*, surface view; *b*, peripheral view.
3. *Alveolina boscii*, × 12. *a*, front view; *b*, end view. (After Brady.)
4. *Alveolina melo*, × 33. *a*, front view; *b*, end view. (After Brady.)



MILIOLIDAE OF NORTH PACIFIC OCEAN

FOR EXPLANATION OF PLATE SEE PAGE 99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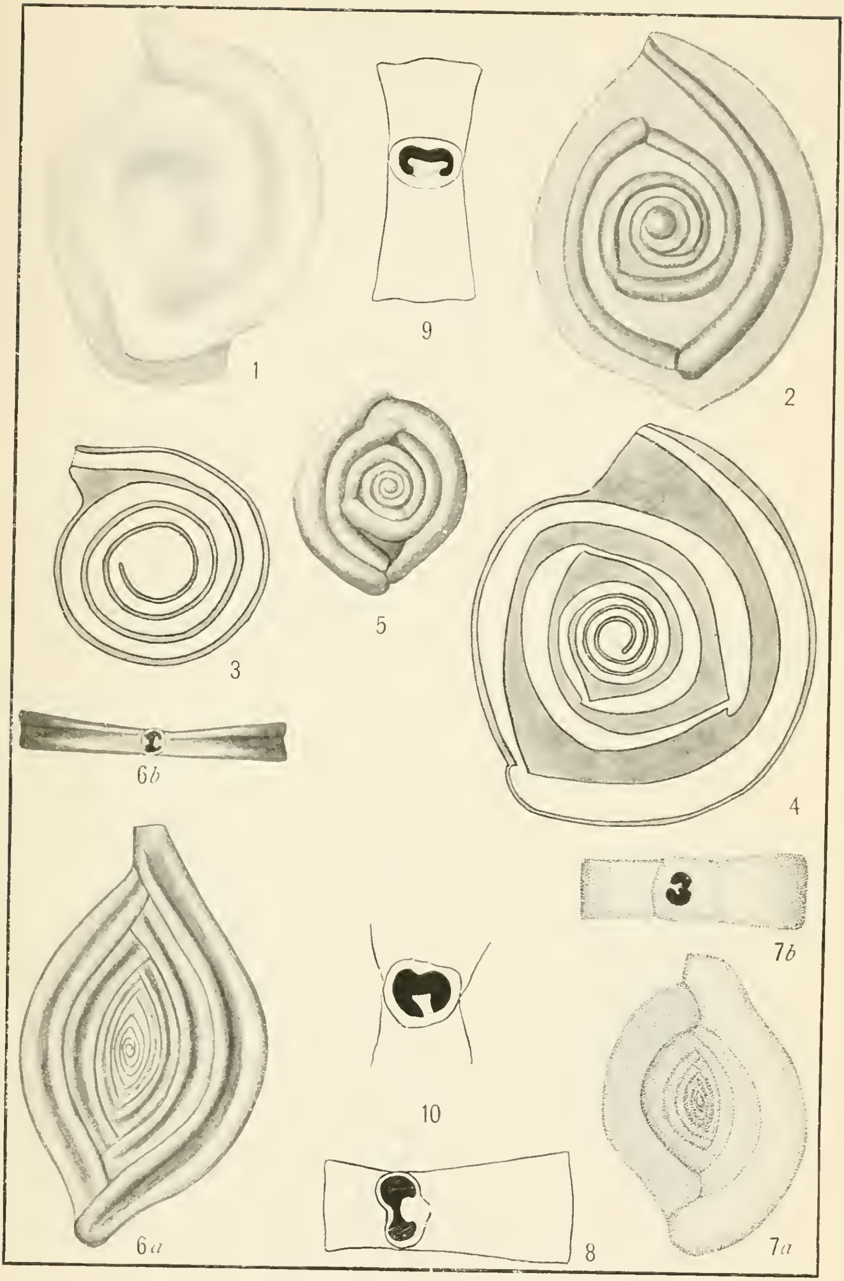
2a
2b
3b
3a

MILIOLIDAE OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 99.


9
1
2
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6b
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10
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8
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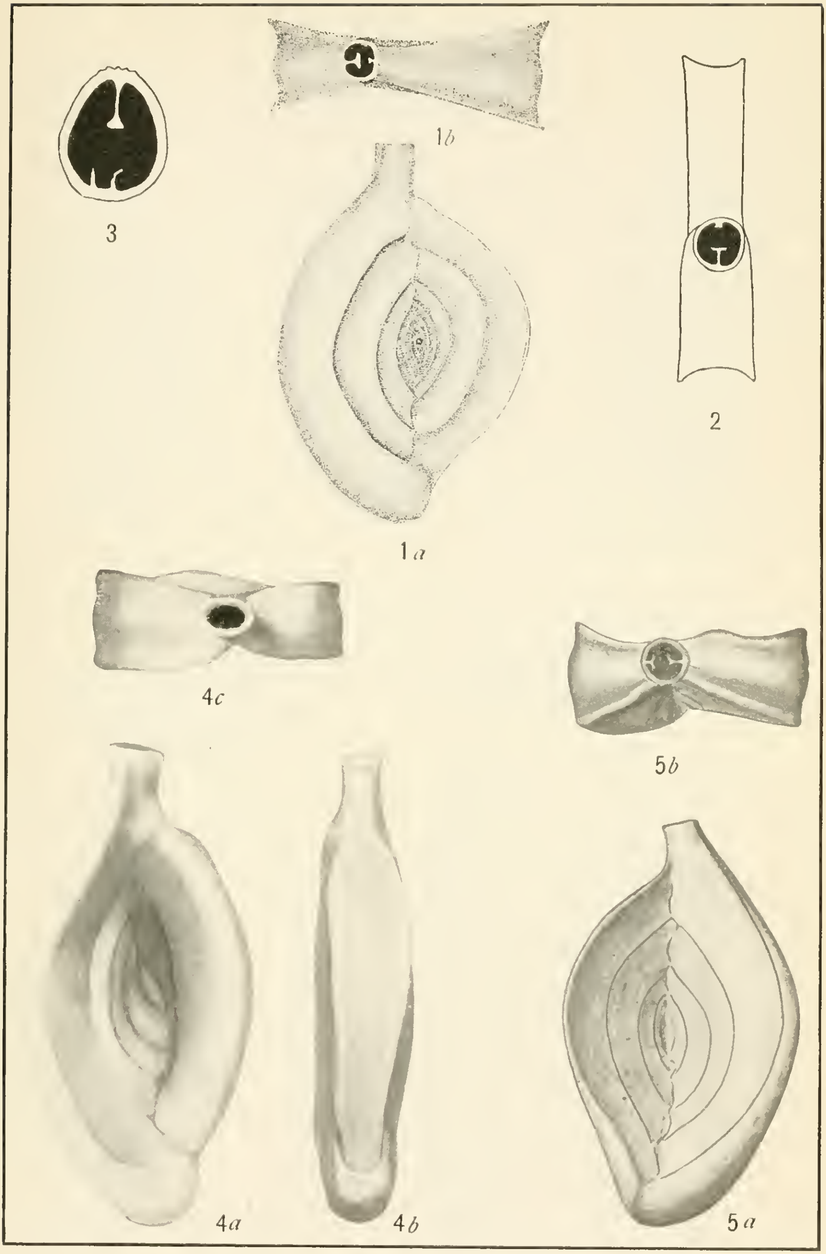
MILIOLIDAE OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 99.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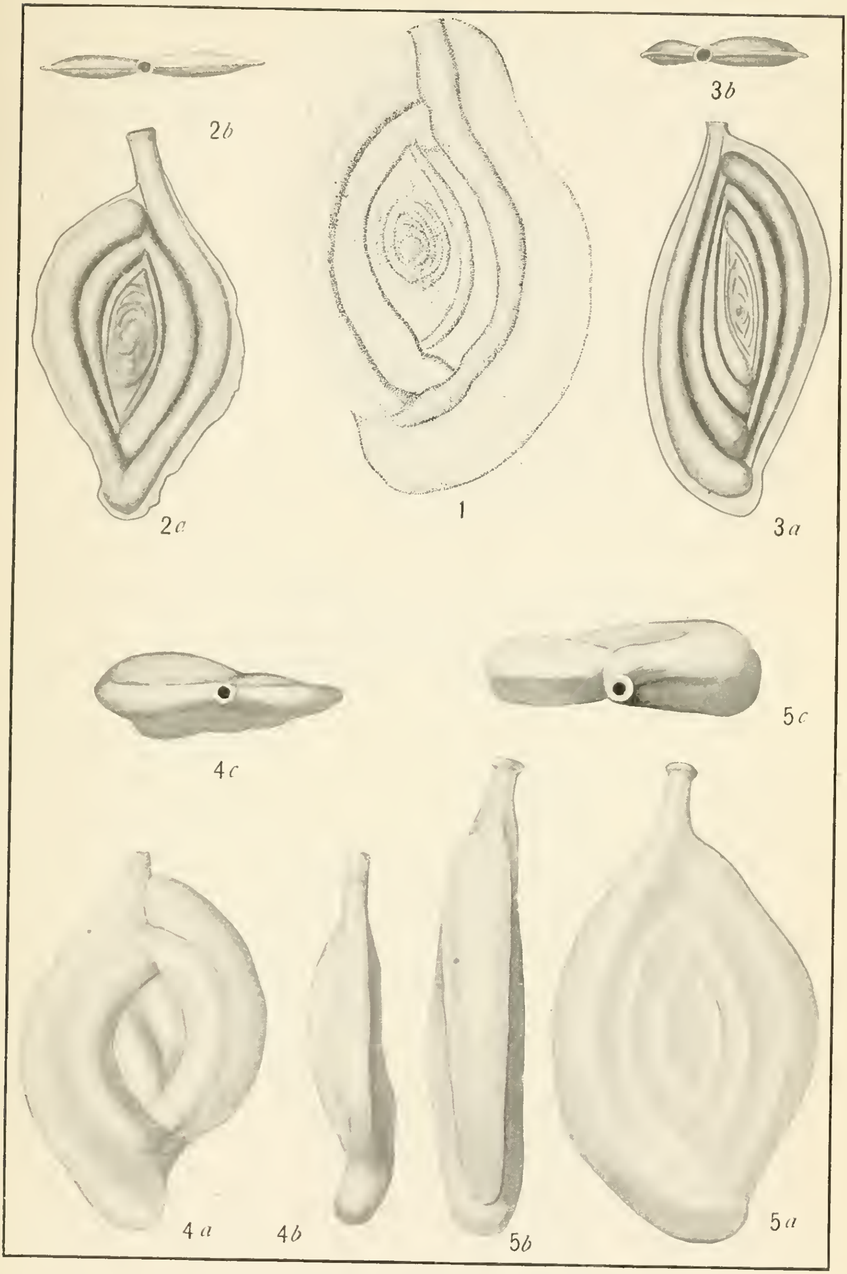
1*a*
4*c*
5*b*
4*a*
4*b*
5*a*

Miliolidae of North Pacific Ocean.

For explanation of plate see page 99.


2b
3b
2a
1
3a
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4c
4a
4b
5b
5a

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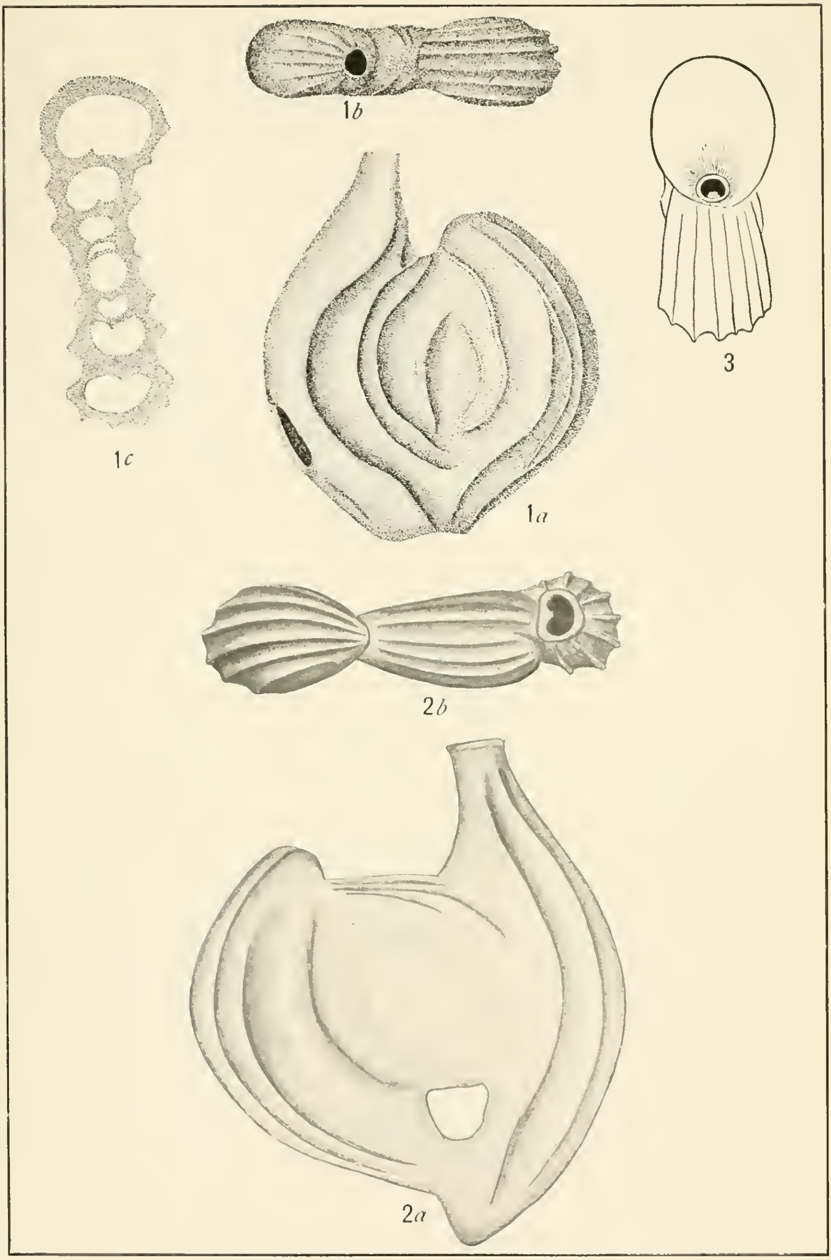
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2a

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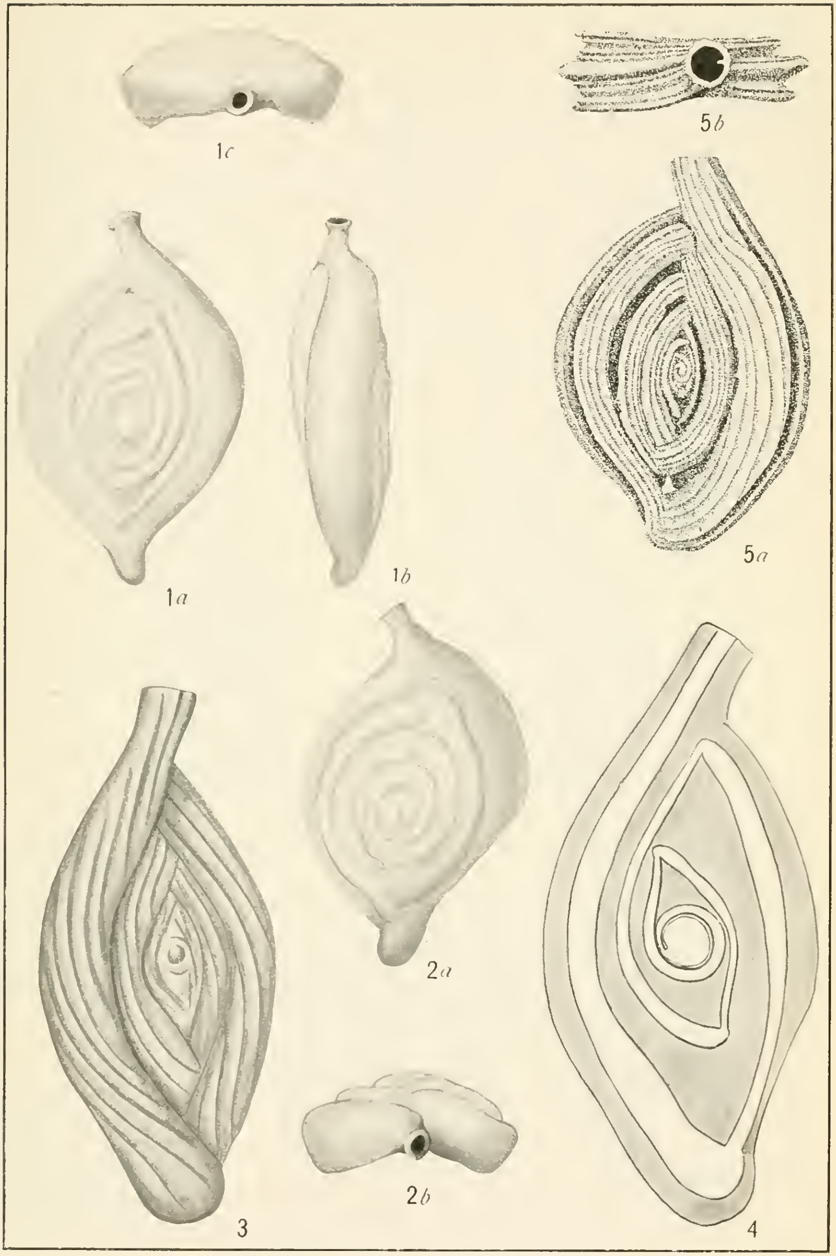
For explanation of plate see page 99.


1c
5b
1a
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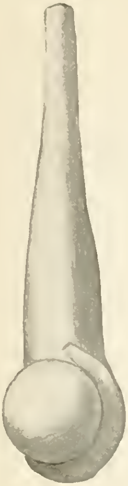
FOR EXPLANATION OF PLATE SEE PAGE 99.



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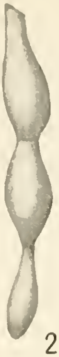

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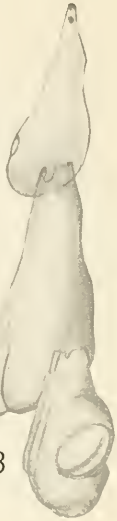

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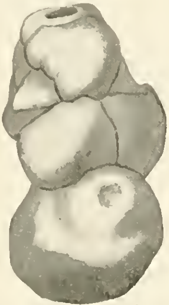

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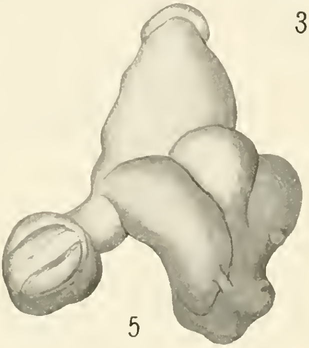

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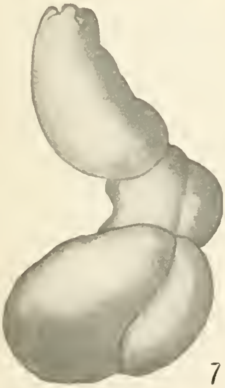

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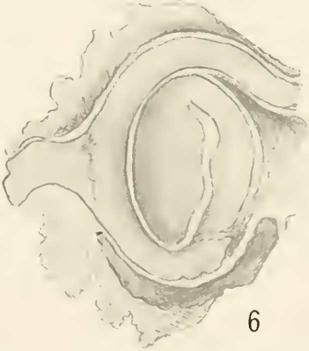

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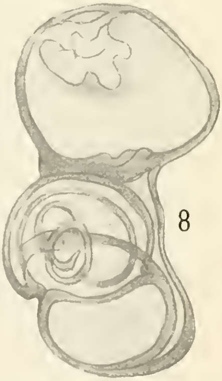

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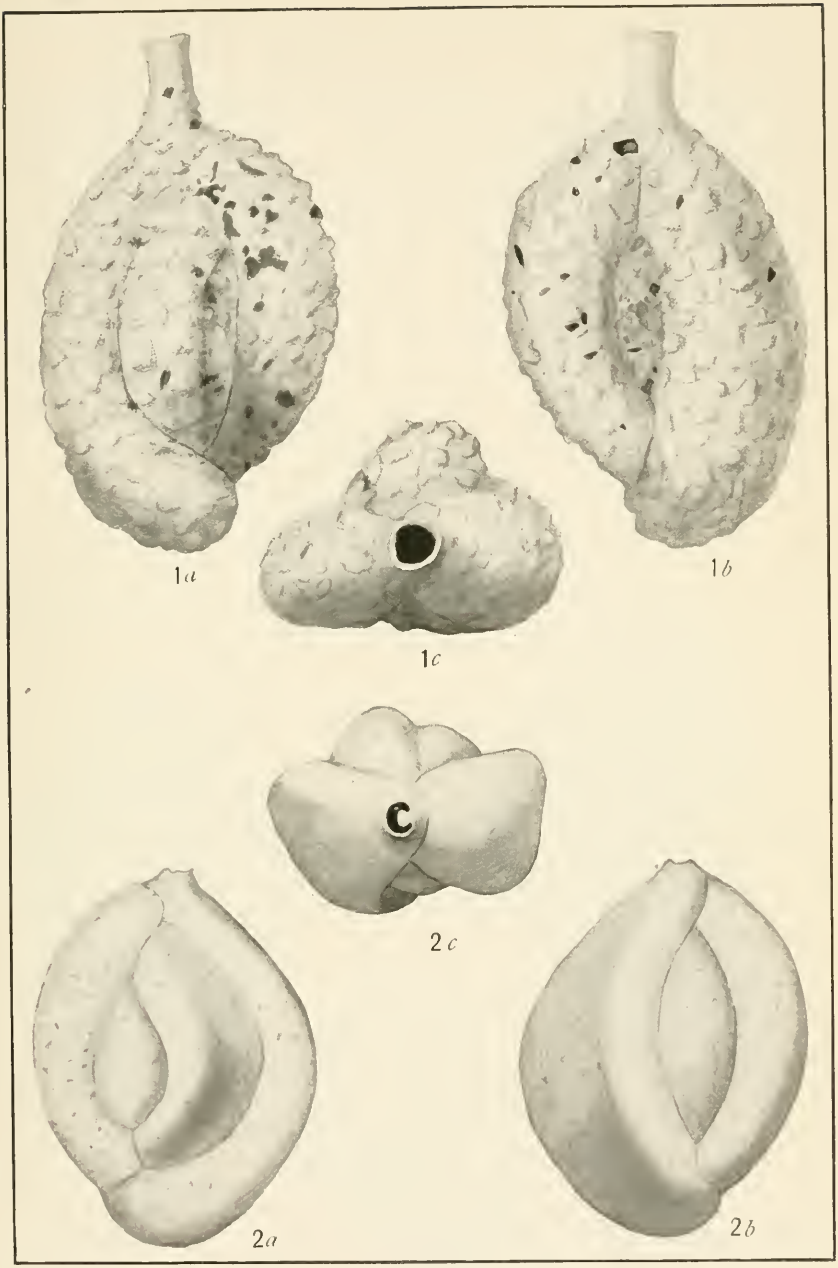
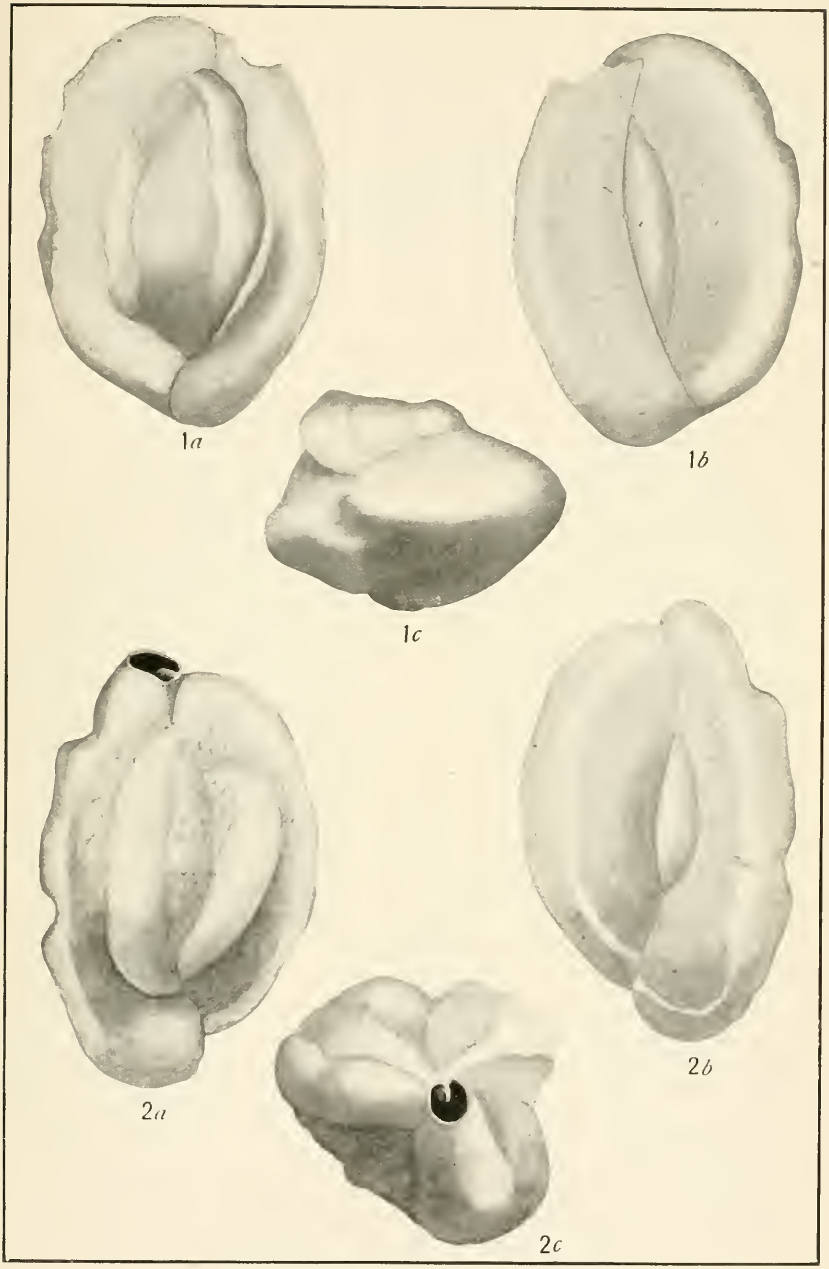
For explanation of plate see page 100.


1a
1b
1c
2c
2a
2b

Miliolidae of North Pacific Ocean.

For explanation of plate see page 100.


1a
1b
1c
2a
2b
2c

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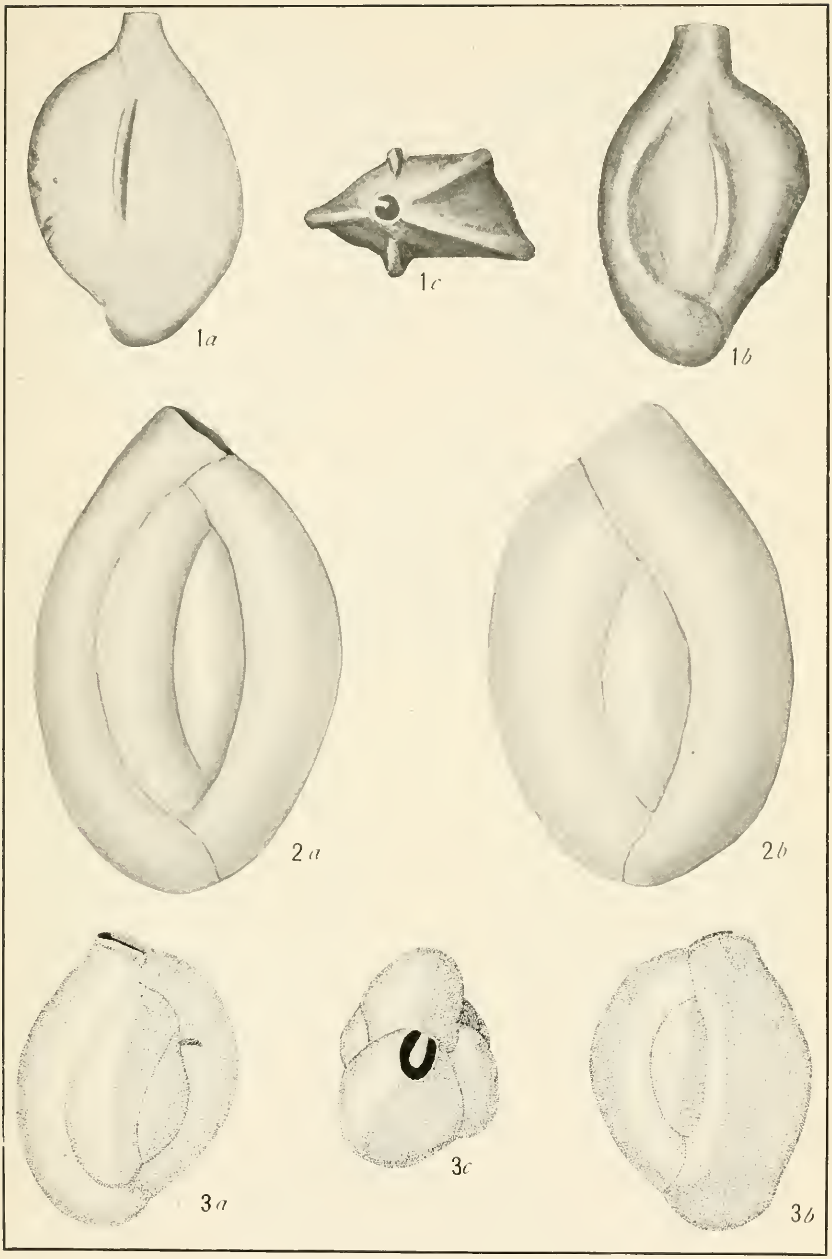
For explanation of plate see page 100.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1c
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2a
2b
3a
3c
3b

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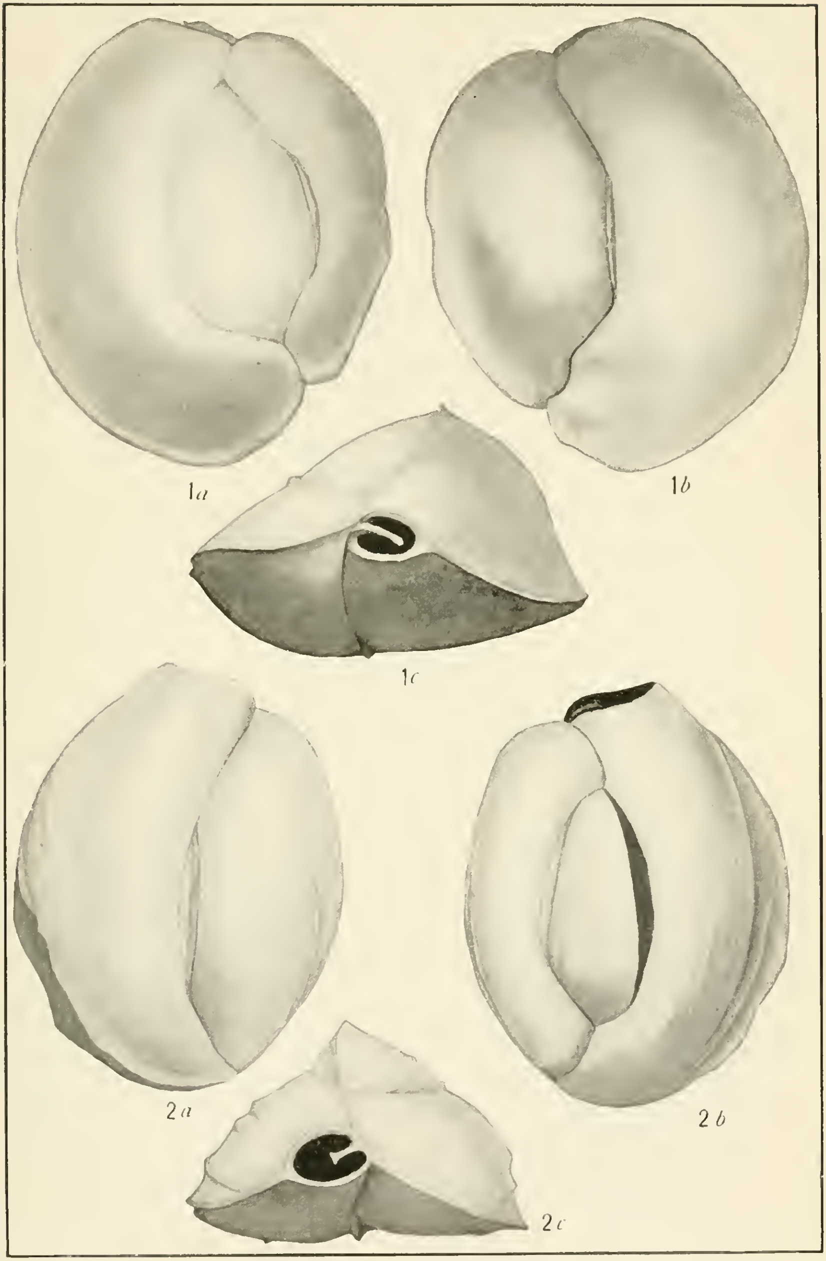
For explanation of plate see page 100.


1a
1b
1c
2a
2b
2c

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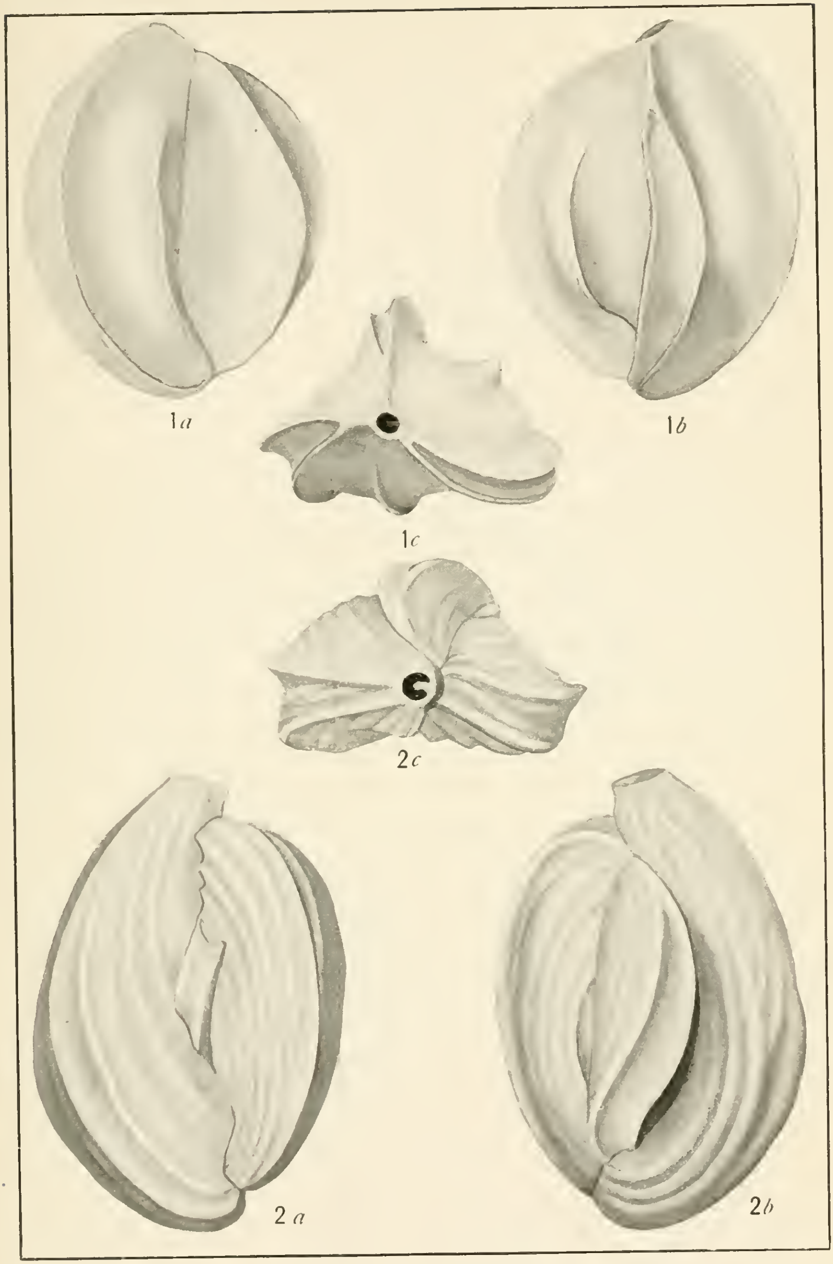
1a
1b
1c
2c
2a
2b

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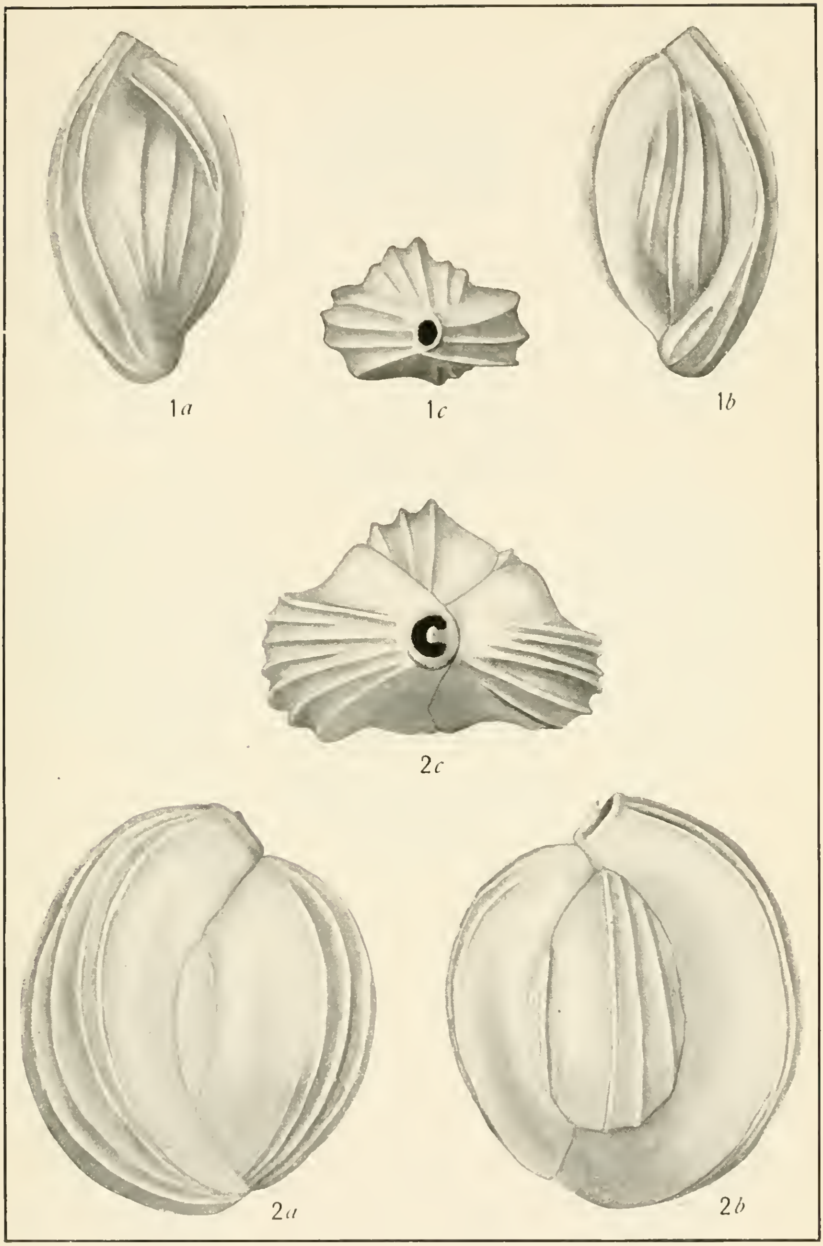
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2c
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2b

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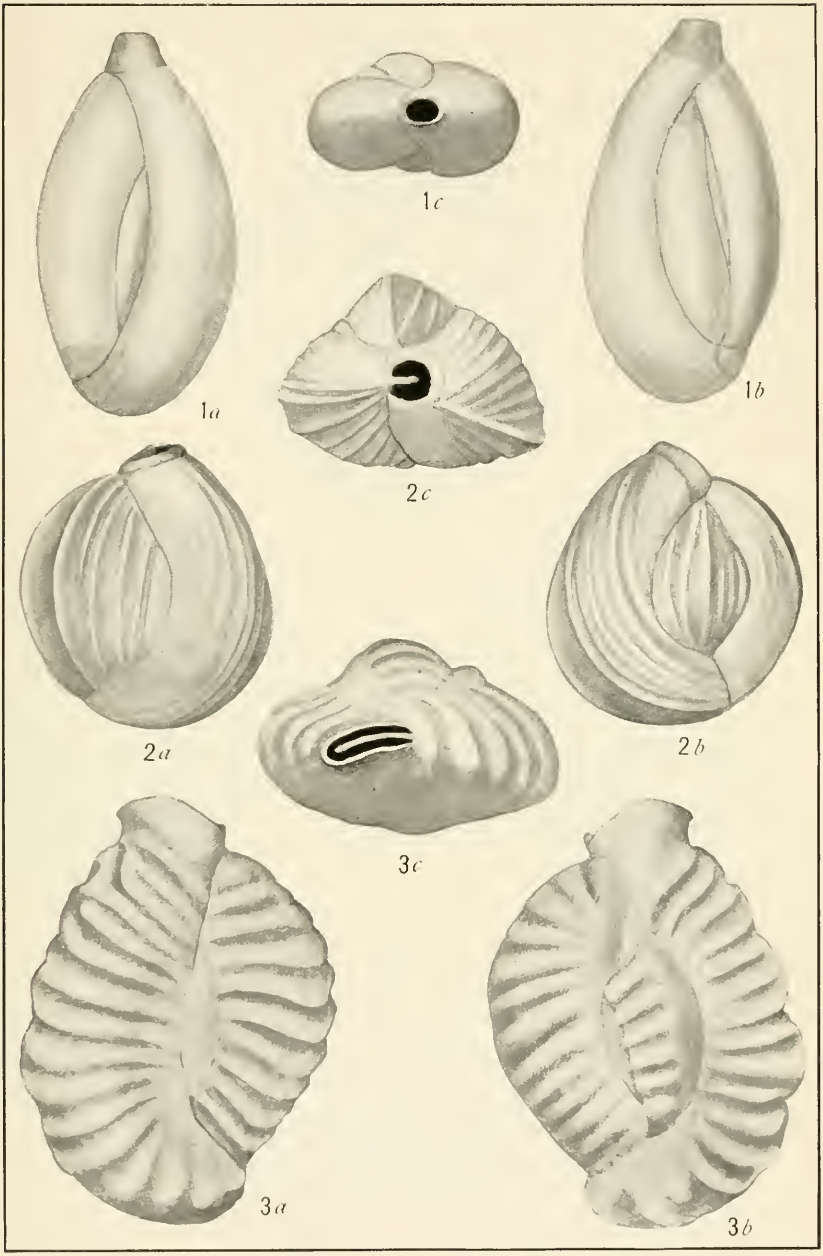
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3a
3b
3c

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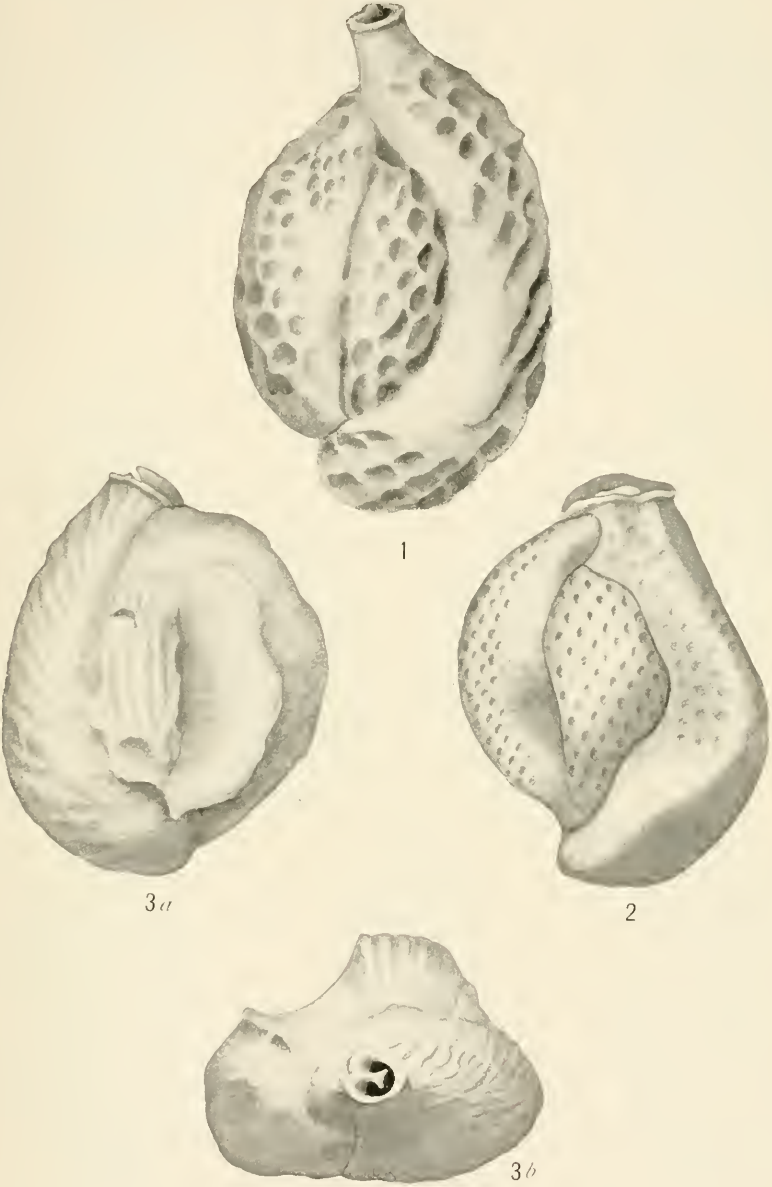

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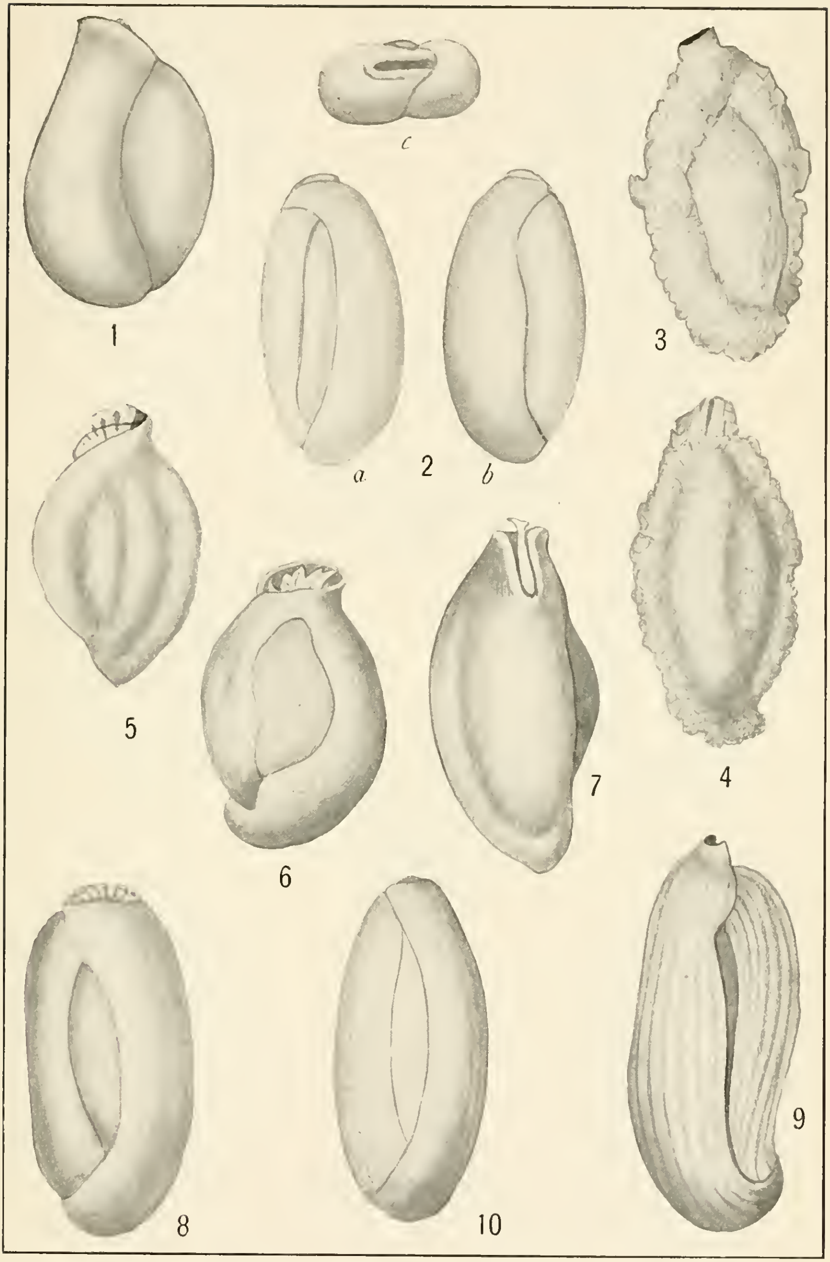
For explanation of plate see page 101.


1
c
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9

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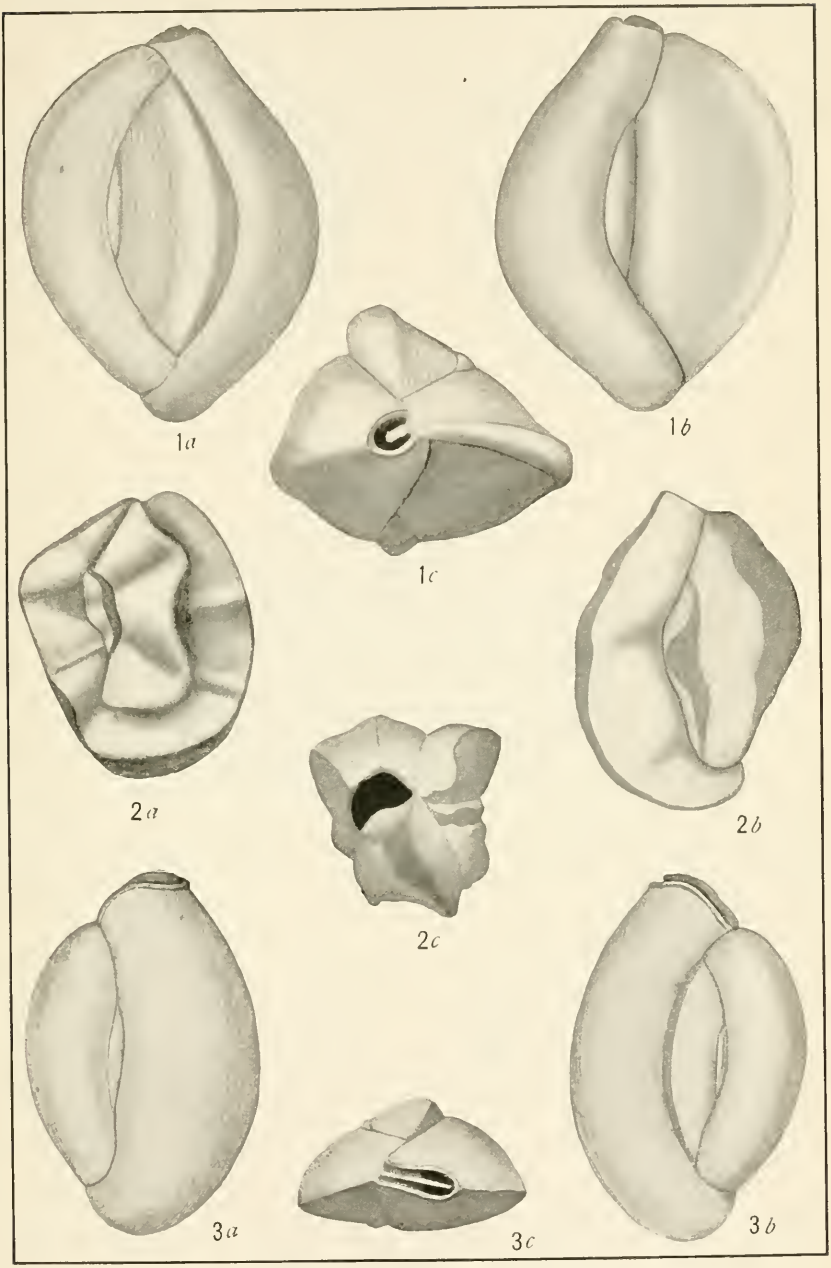
For explanation of plate see page 101.


1a
1b
1c
2a
2b
2c
3a
3b
3c

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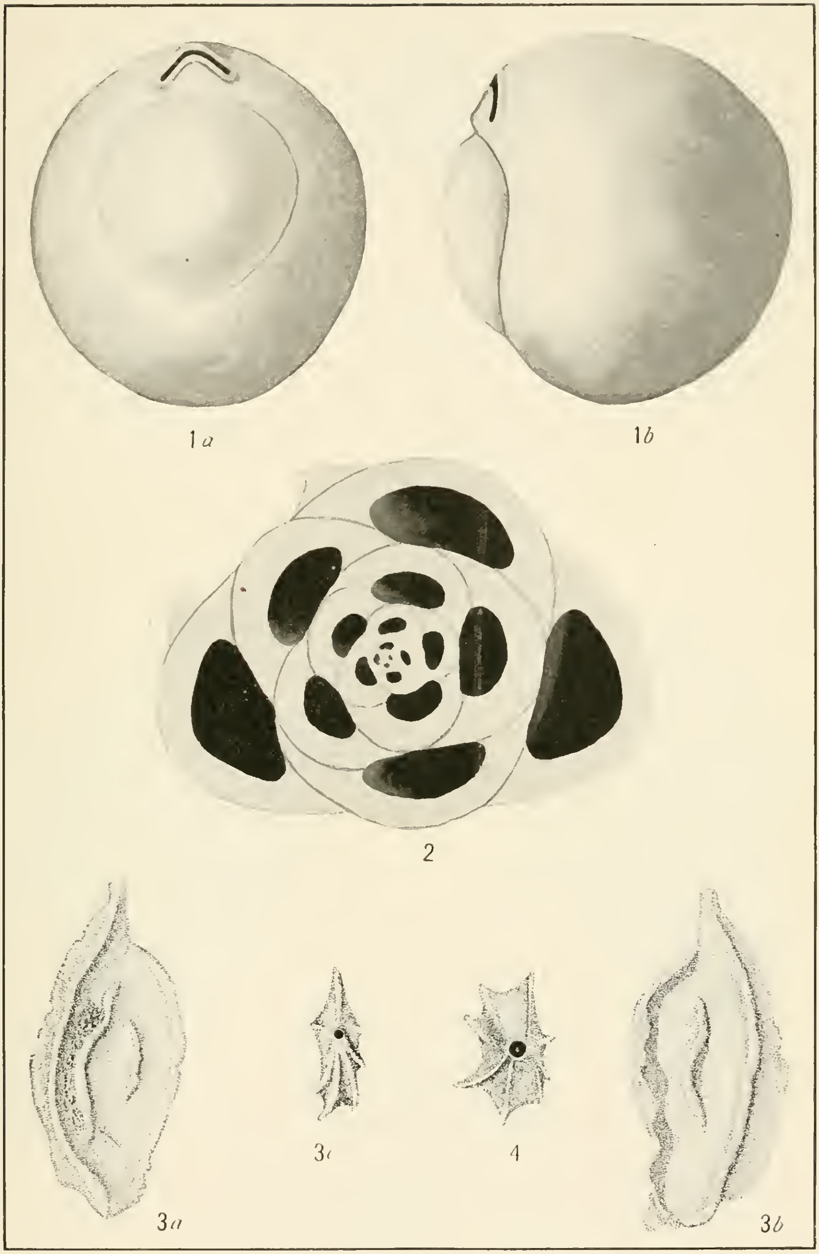
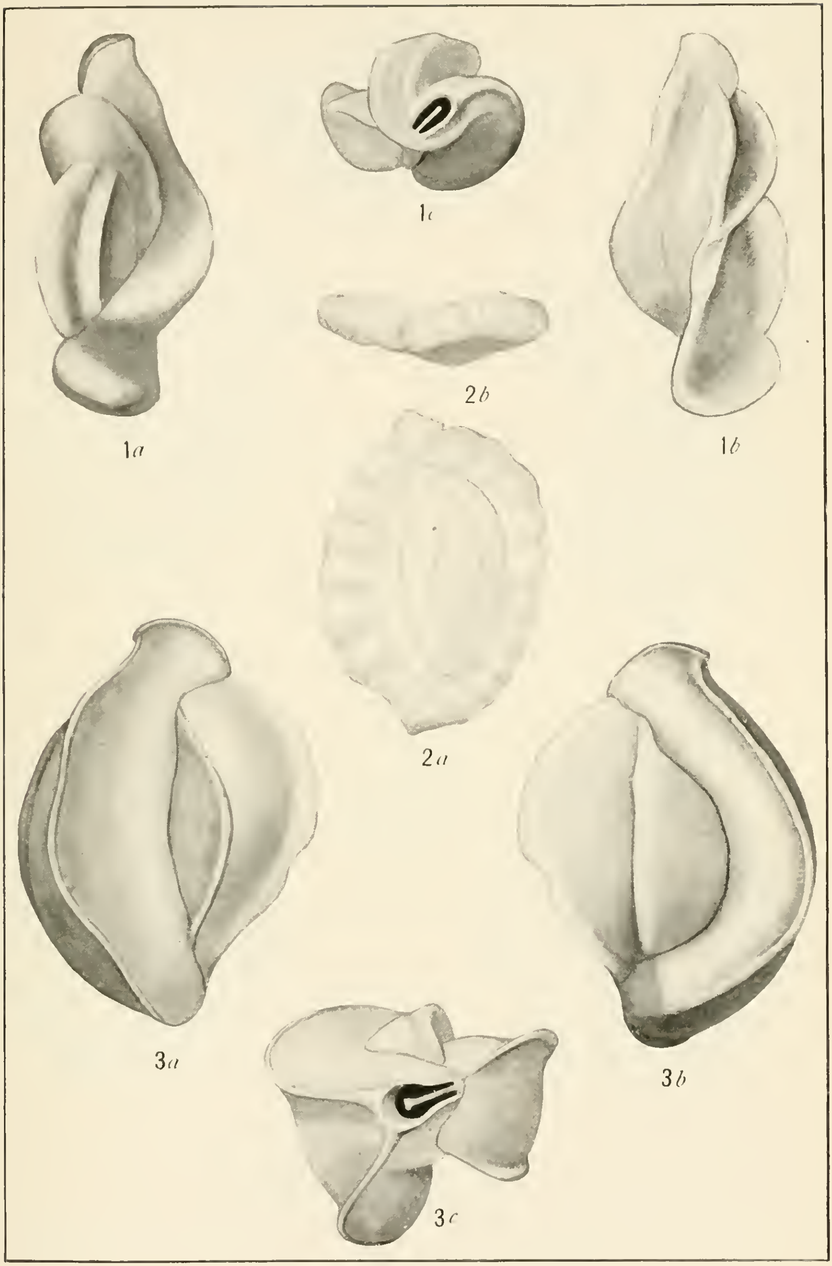
For explanation of plate see page 101.


1a
1b
2
3c
4
3a
3b

MILIOLIDAE OF NORTH PACIFIC OCEAN

FOR EXPLANATION OF PLATE SEE PAGE 101.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2b
1b
2a
3a
3b
3c

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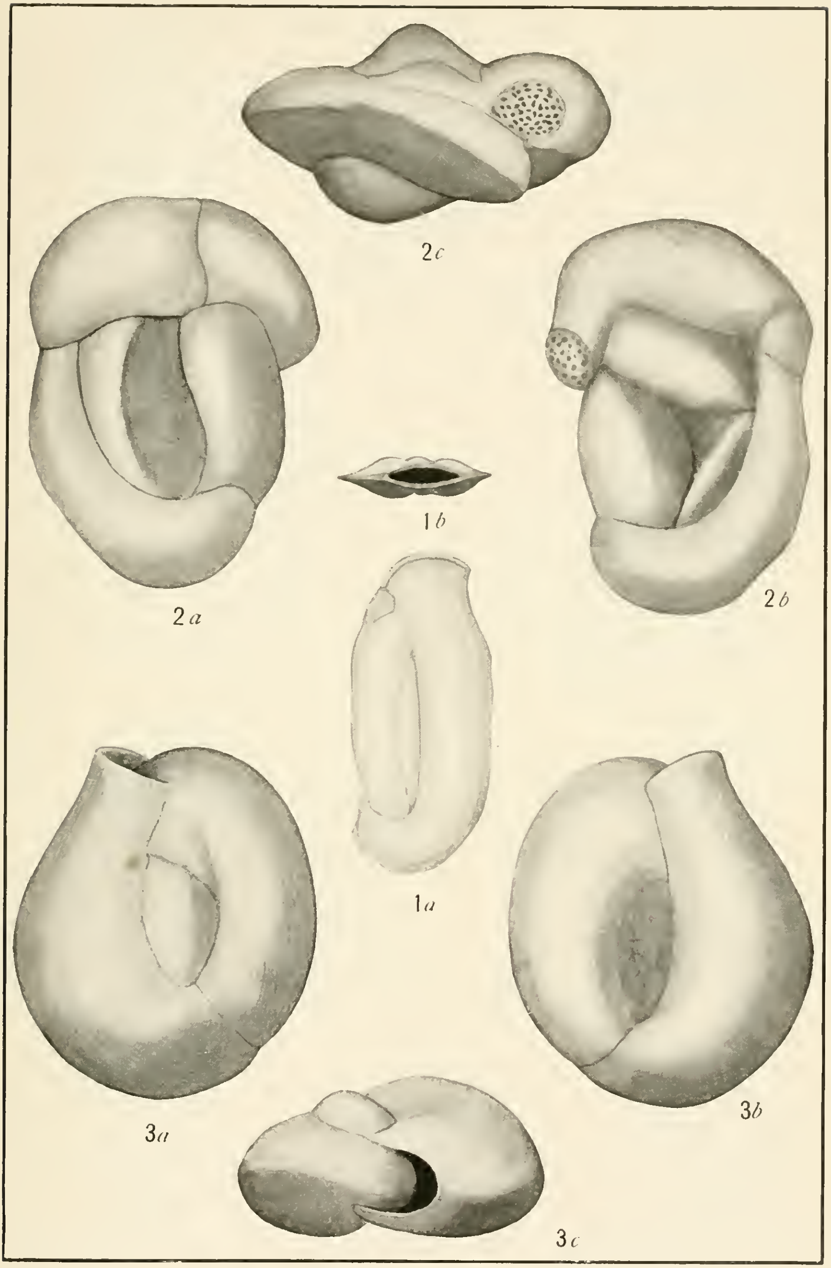
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1a
3a
3b
3c

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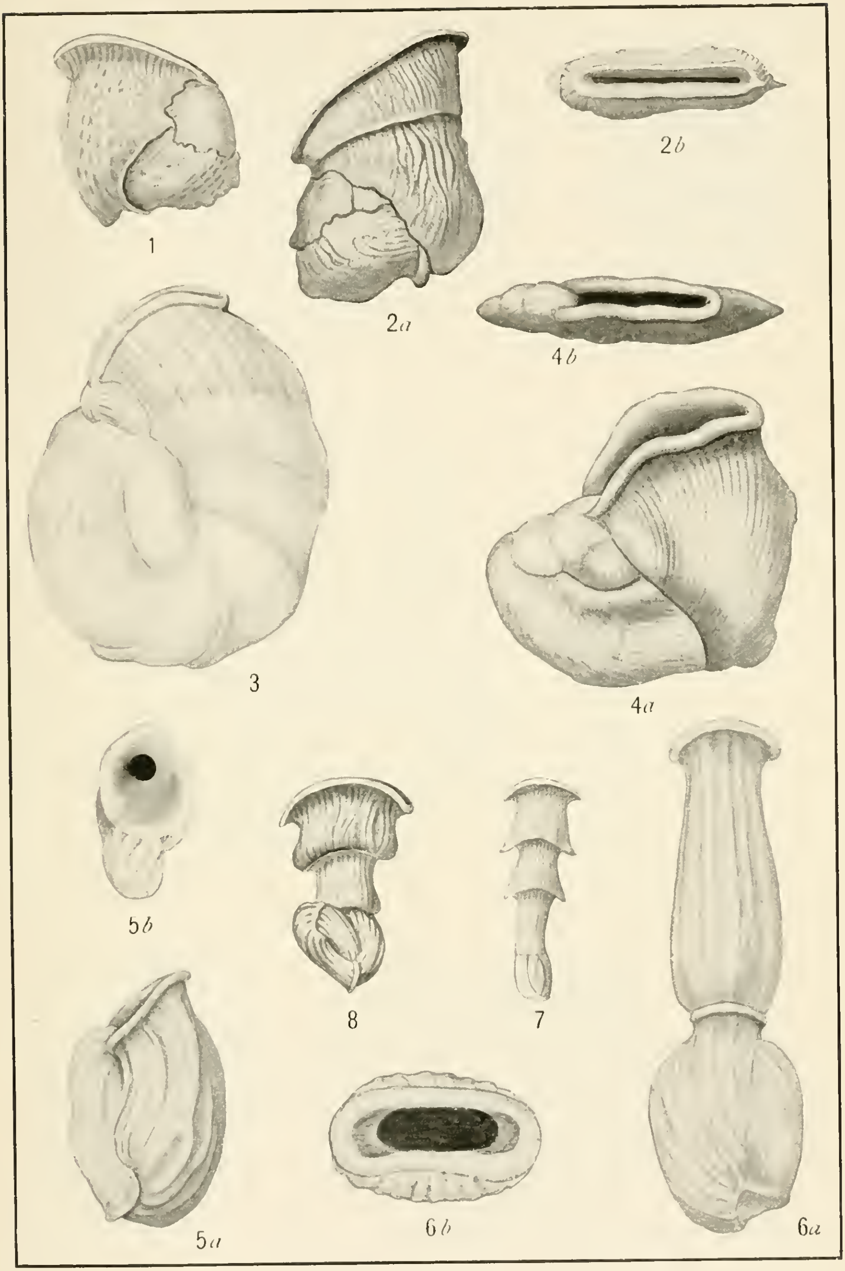
1
2a
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4b
3
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8
7
6a
5a
6b

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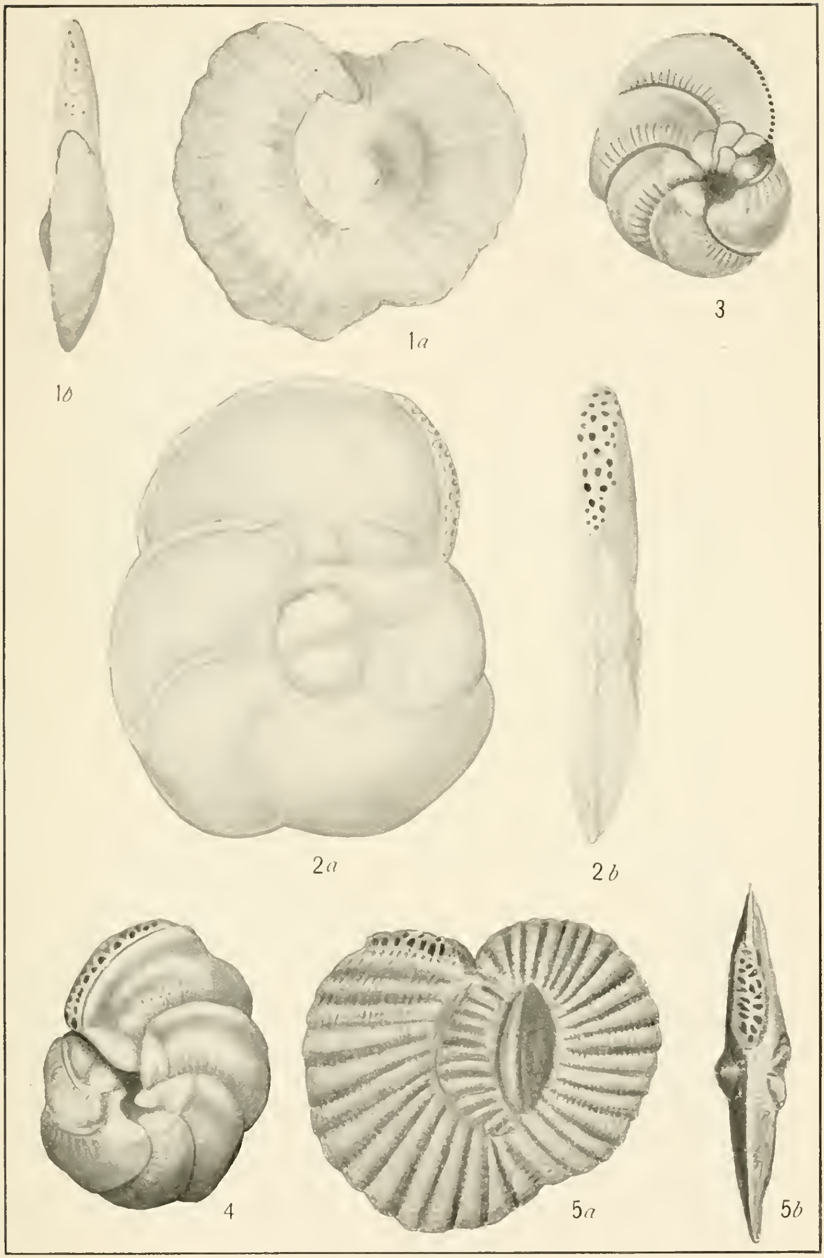
1*b*
1*a*
3
2*a*
2*b*
4
5*a*
5*b*

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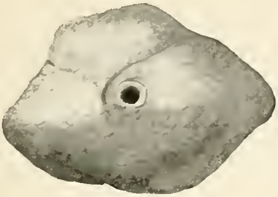
For explanation of plate see page 102.



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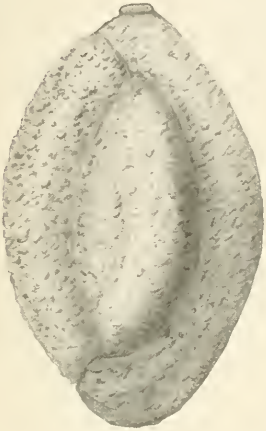
2*b*



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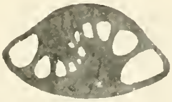

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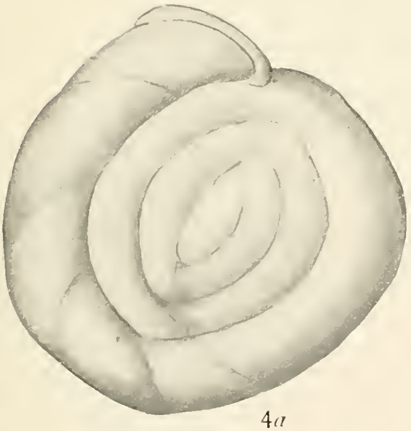

4*a*

4*b*

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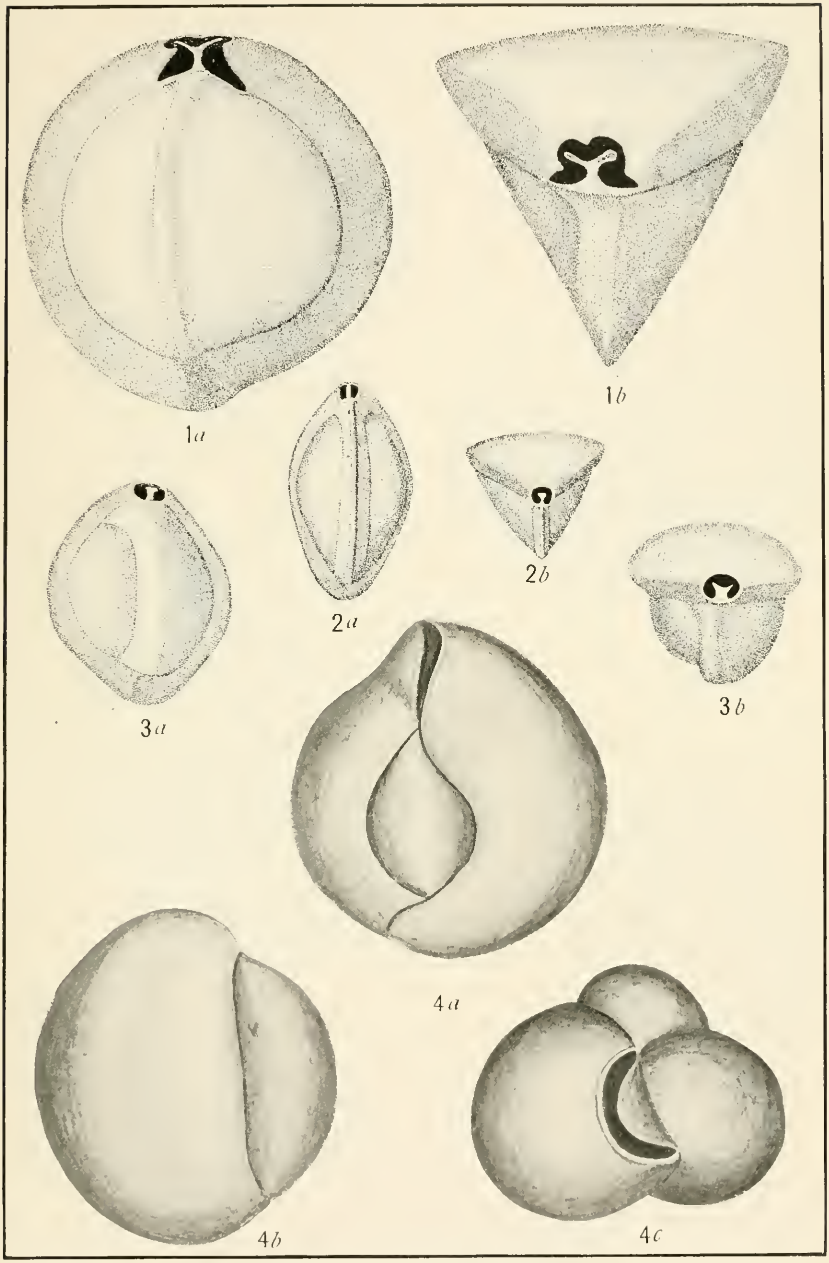
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3b
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4b
4c

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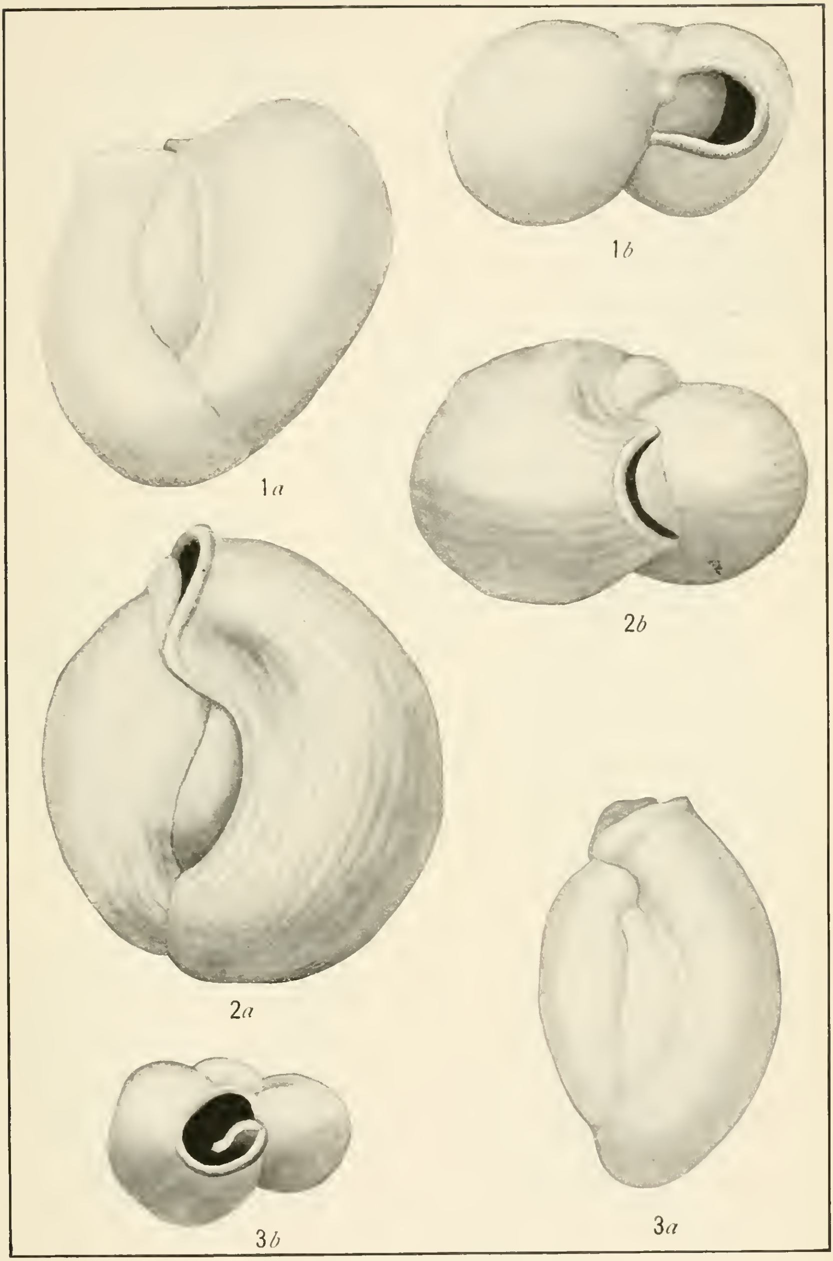
1b
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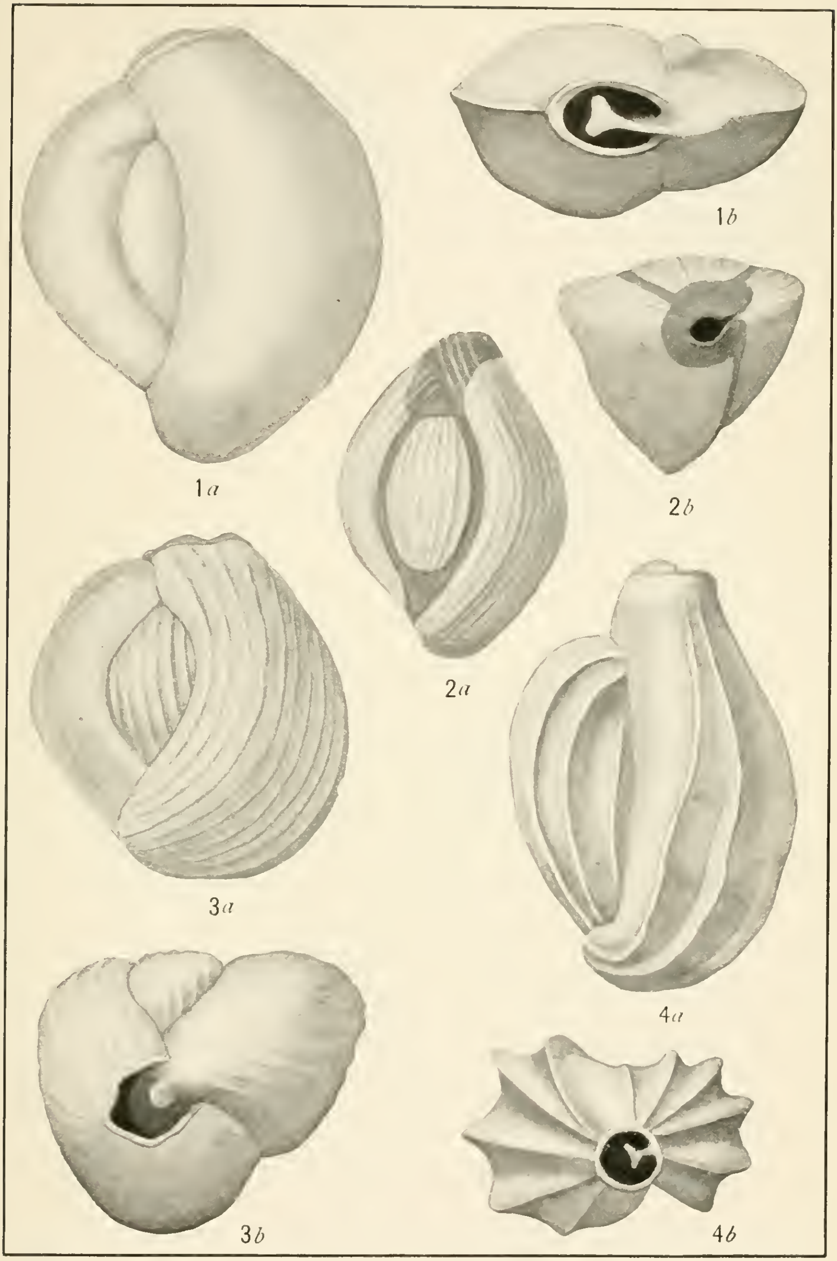
1a
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2b
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3b
4a
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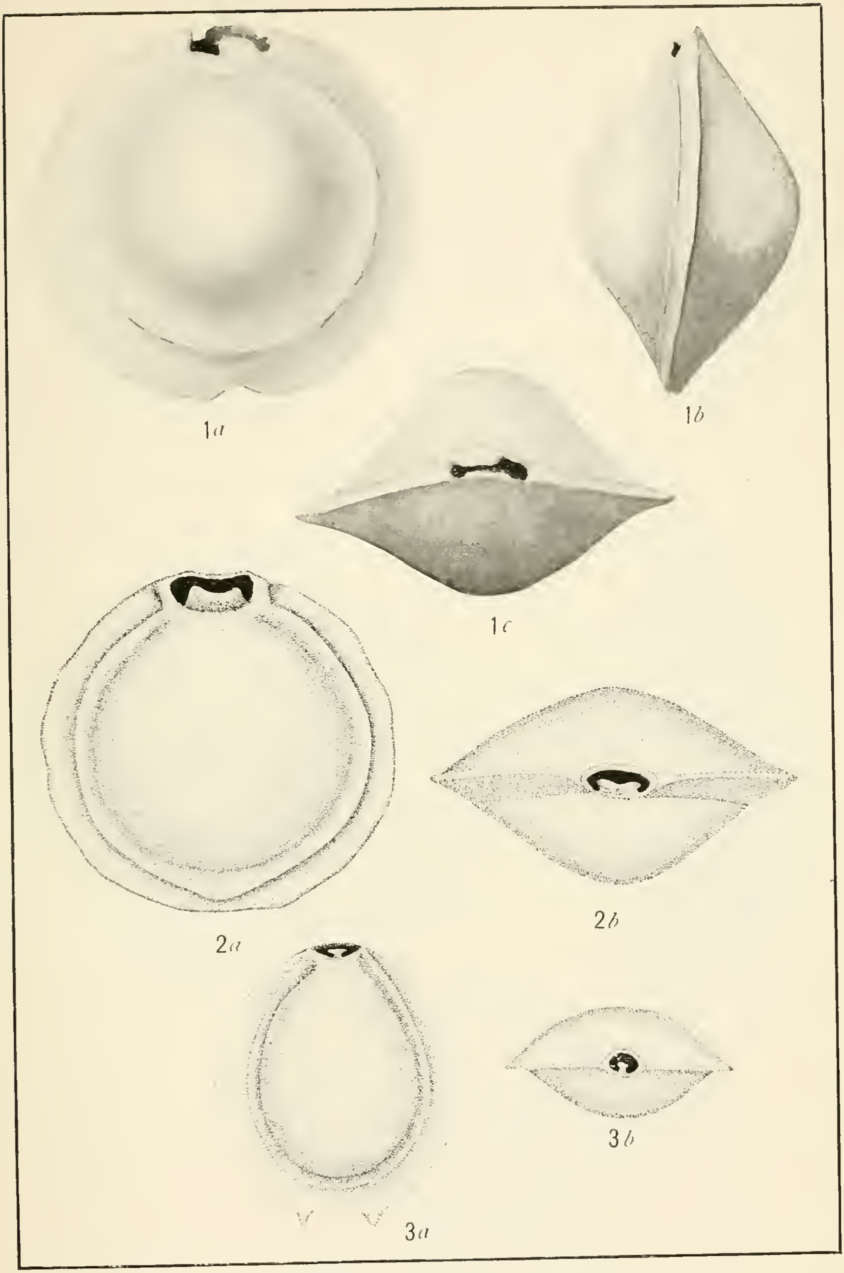
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2b
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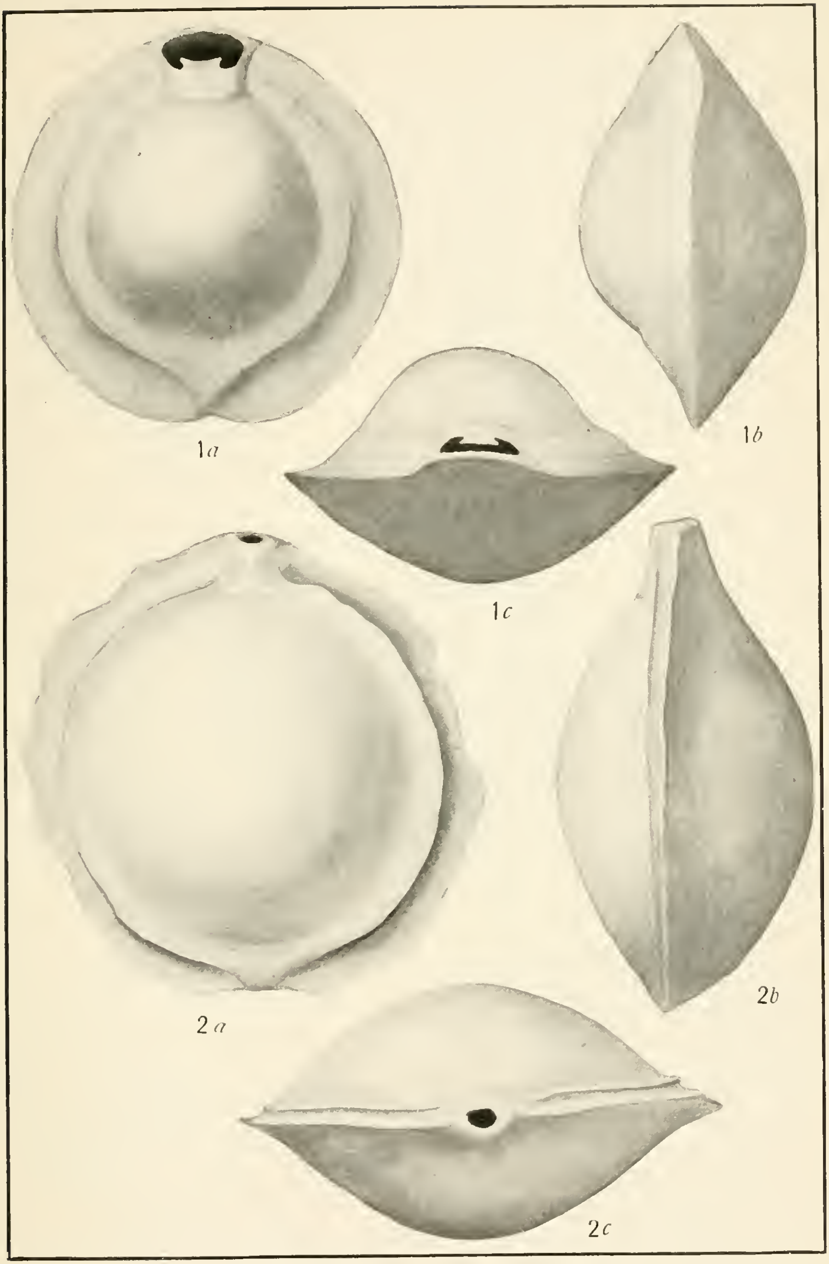
3b

Miliolidae of North Pacific Ocean.

For explanation of plate see page 102.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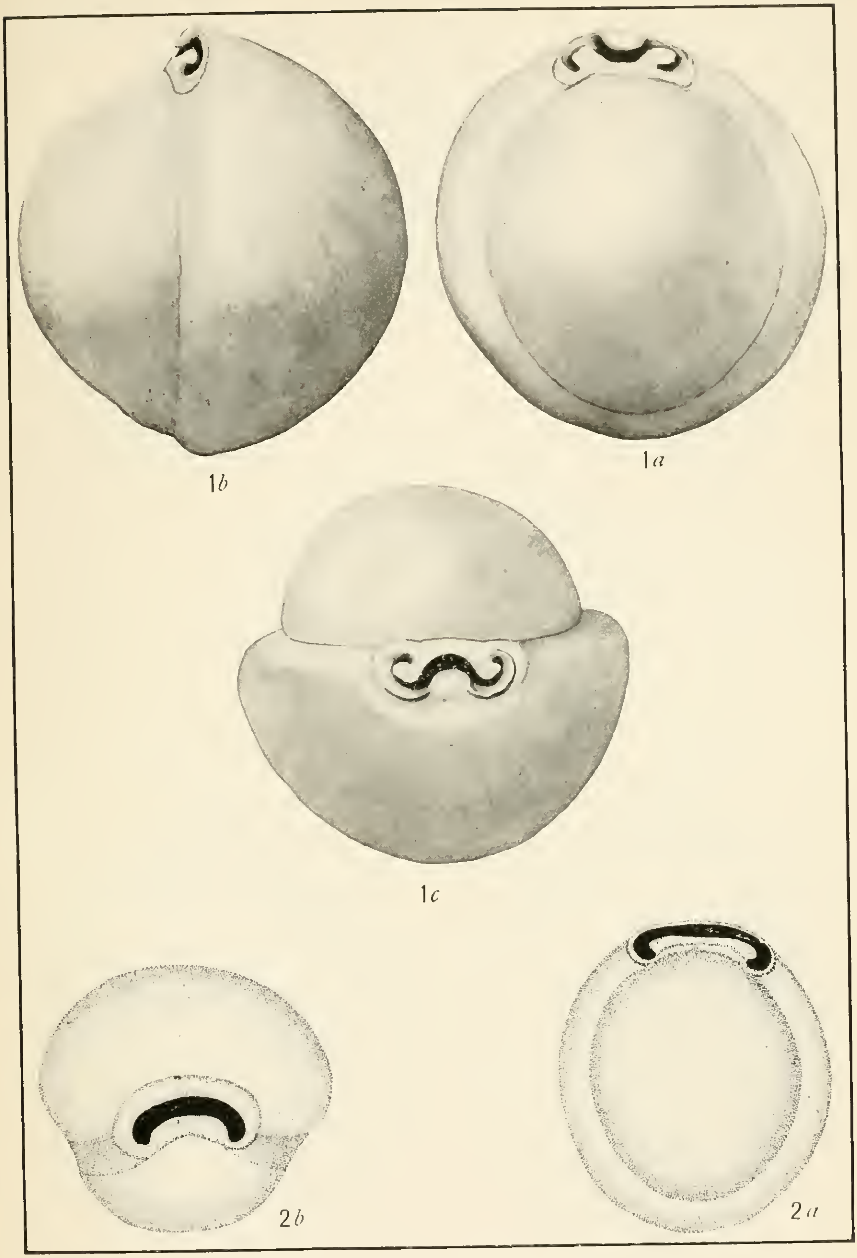

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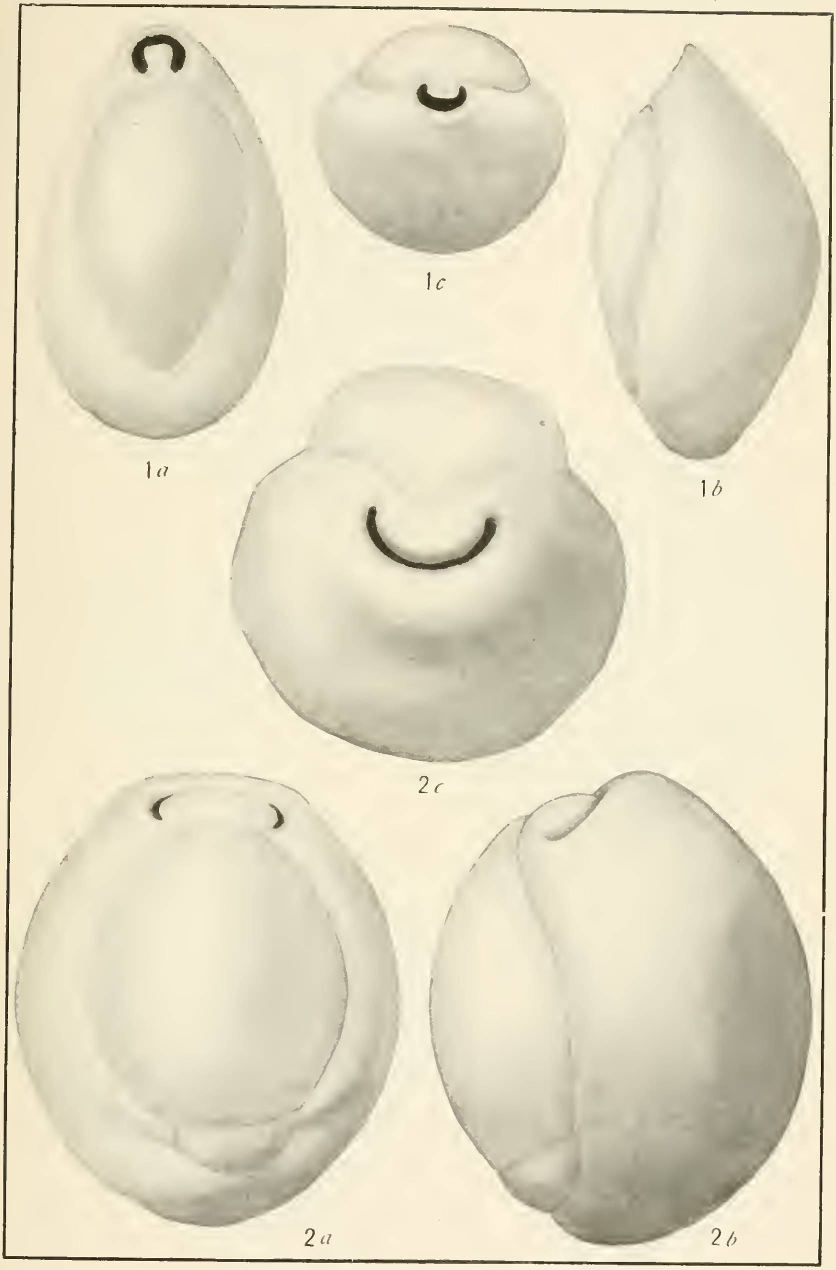
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2c
2a
2b

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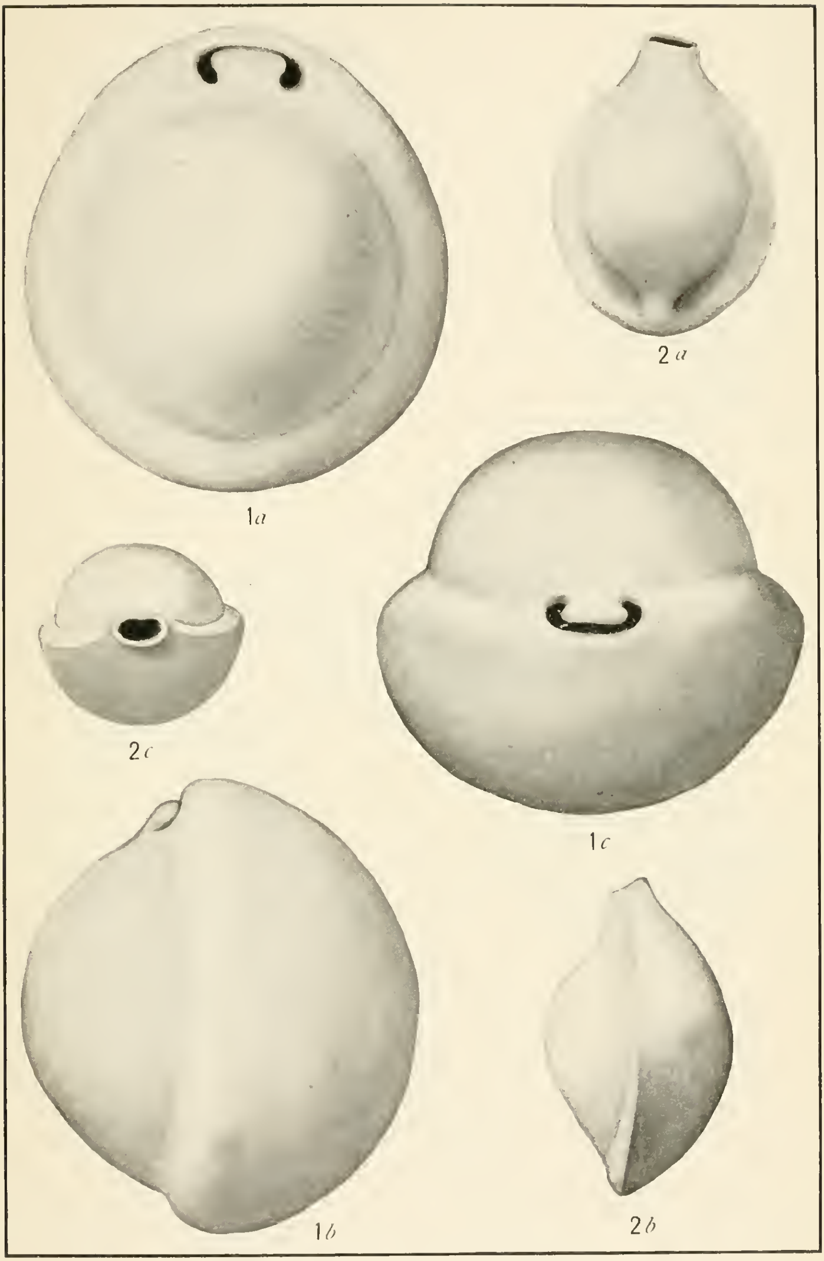
1a
2a
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1c
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2b

MILIOLIDAE OF NORTH PACIFIC OCEAN.

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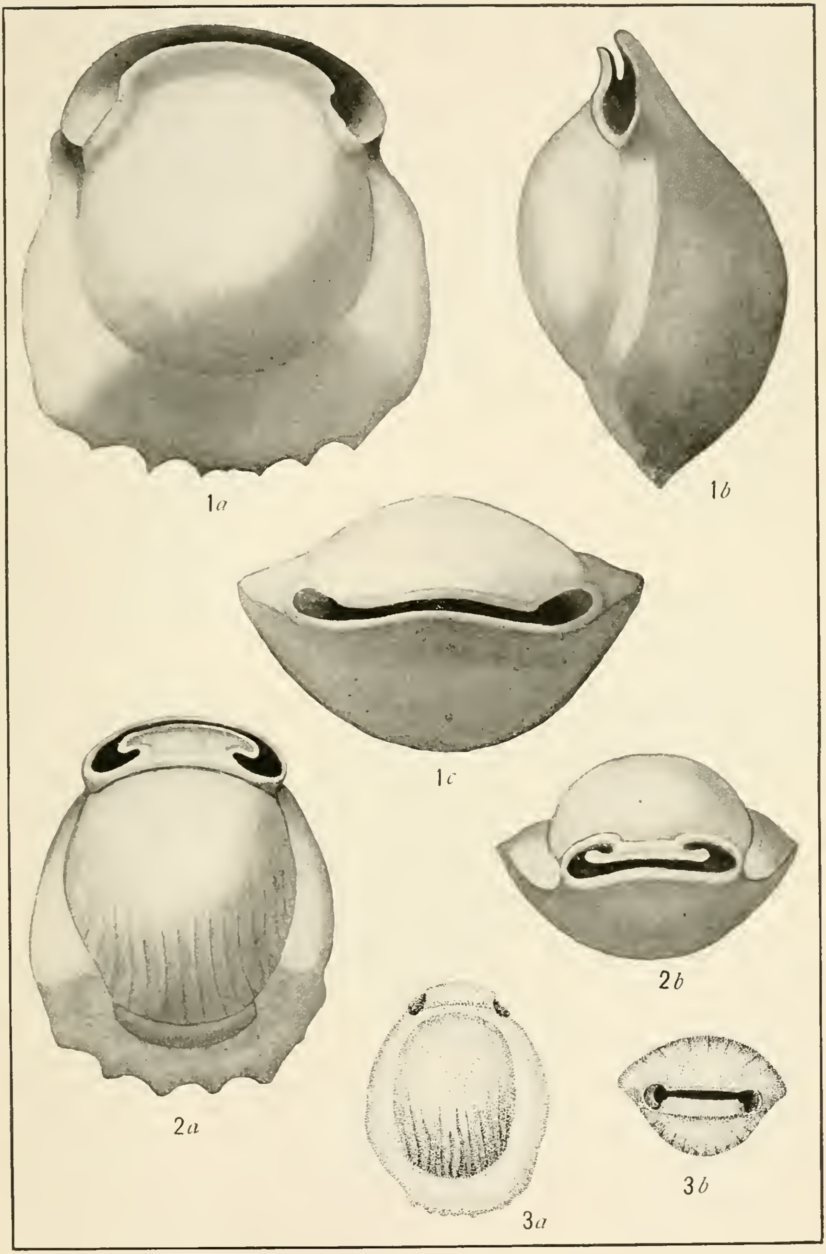
1a
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2a
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3a
3b

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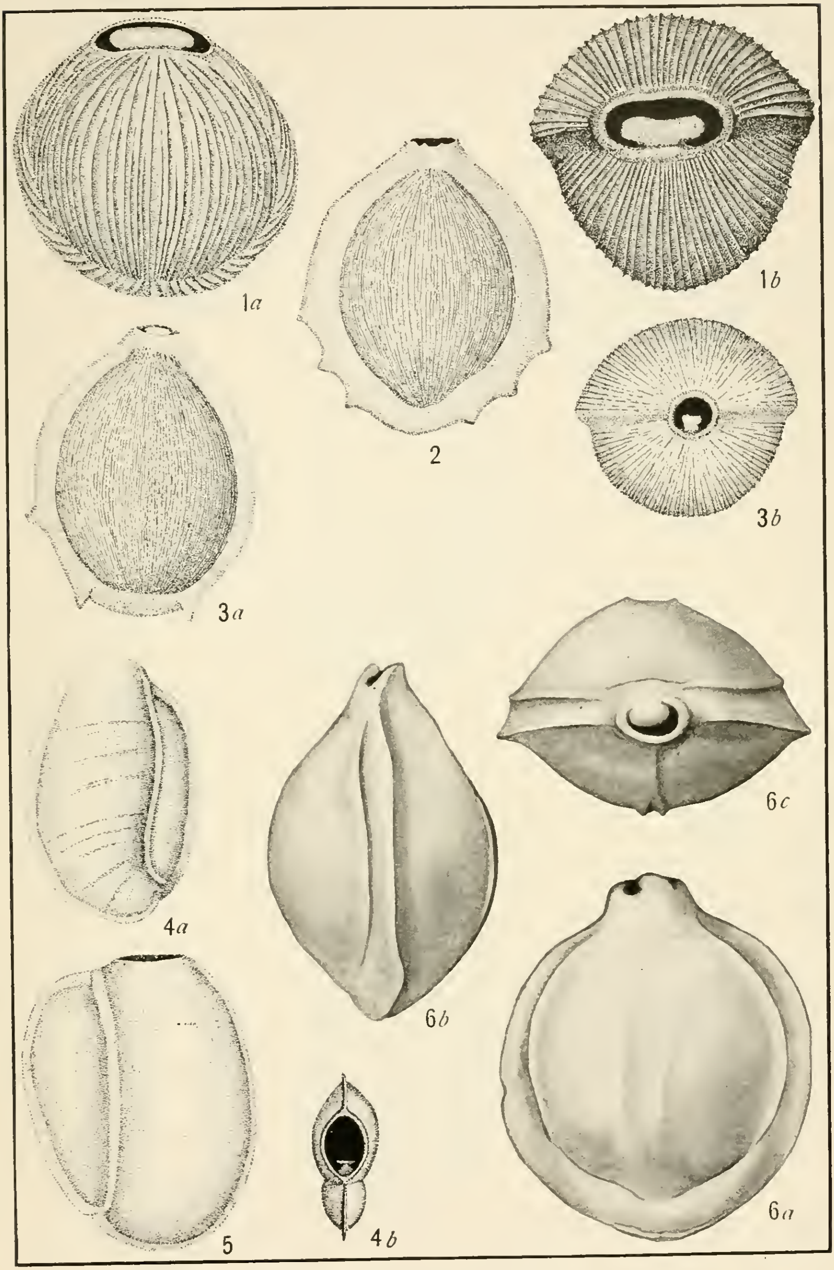
FOR EXPLANATION OF PLATE SEE PAGE 103.


1*a*
1*b*
2
3*a*
3*b*
4*a*
6*b*
6*c*
5
4*b*
6*a*

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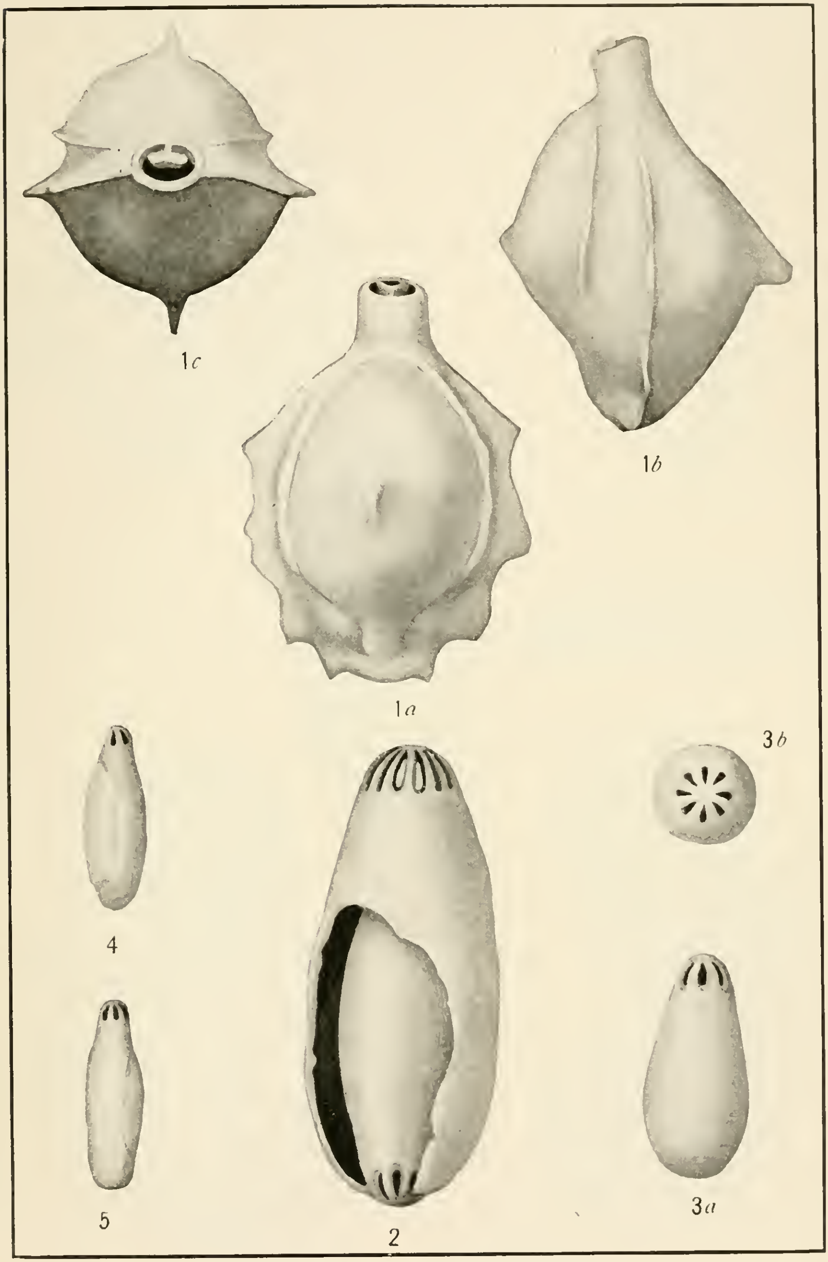
For explanation of plate see page 103.


1c
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4
2
3a
5

Miliolidae of North Pacific Ocean.

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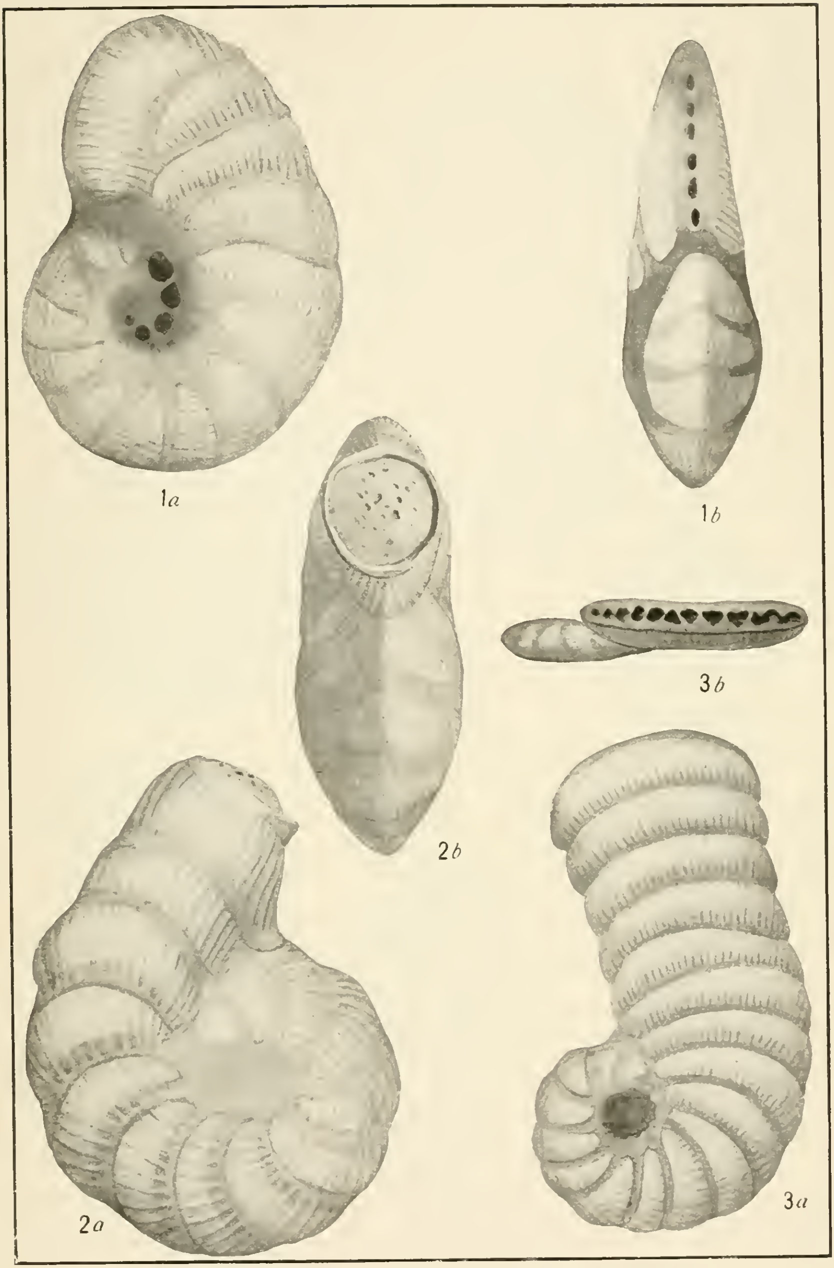
1a
1b
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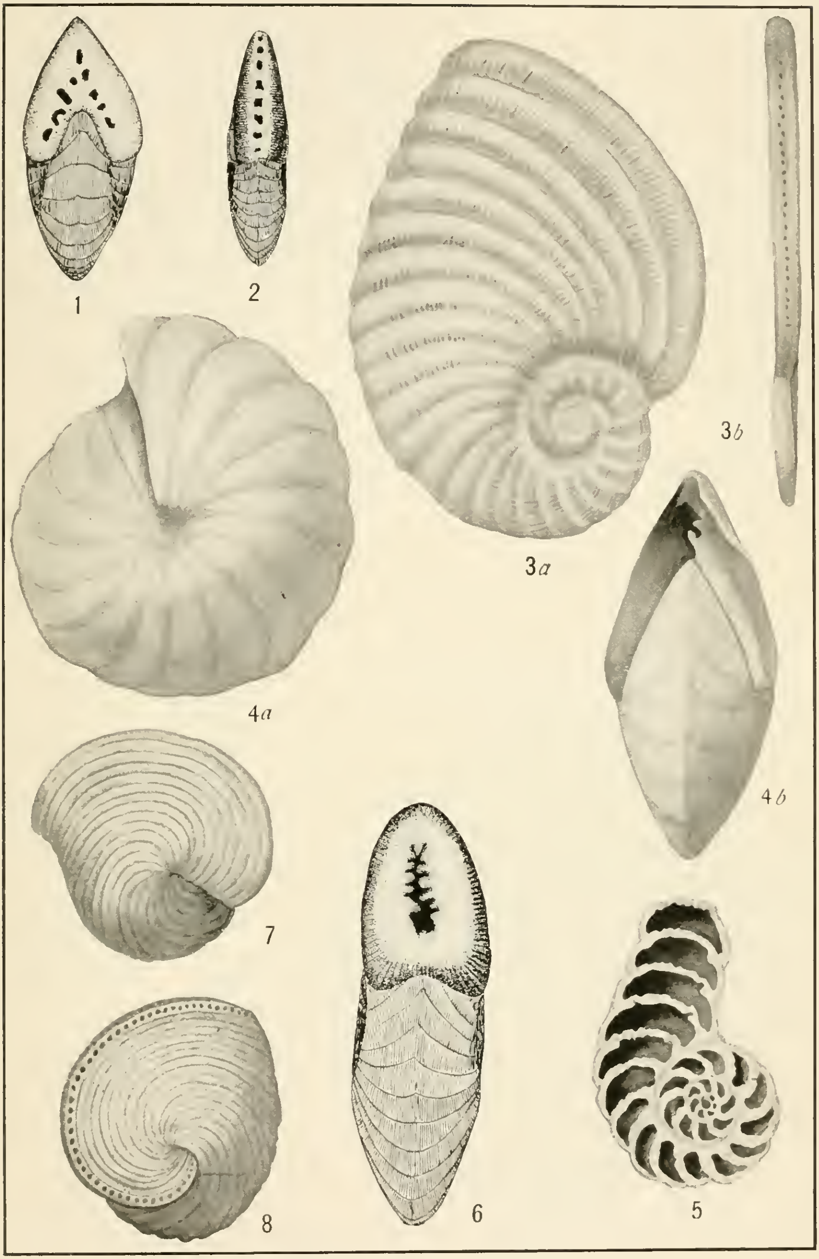
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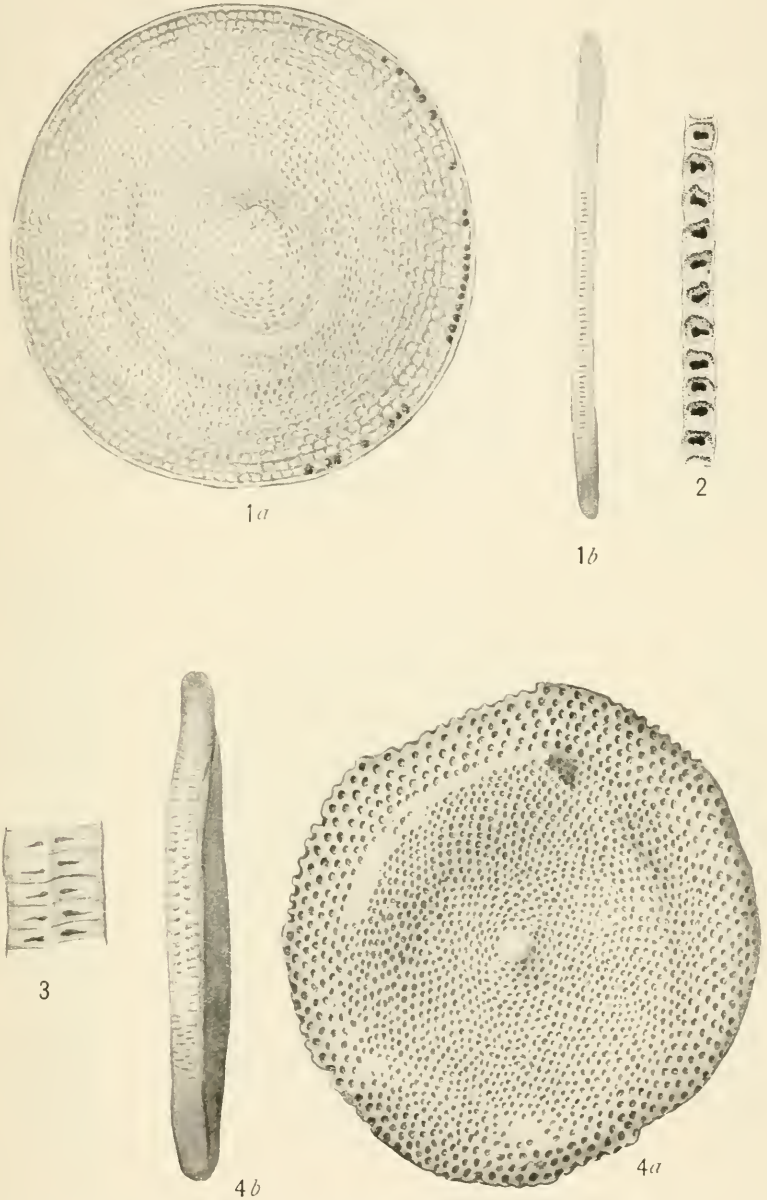

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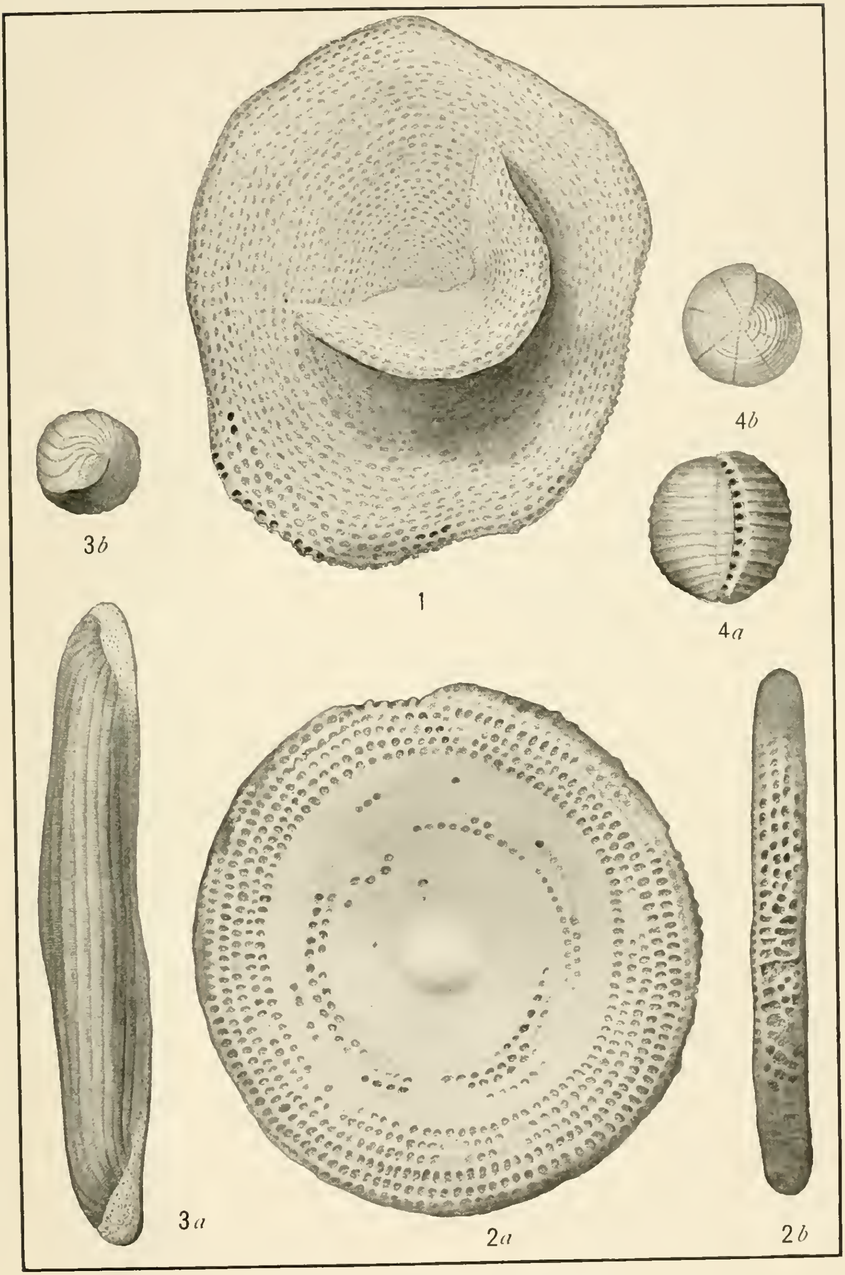
1
4b
3b
4a
3a
2a
2b

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